VOLUME 37
NUMBER 12

DECEMBER, 1950

plating

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See Contents Page 1239

WE extend to you greetings of the Season and Best Wishes for a Prosperous New Year. We also wish to express our deep appreciation for your valued patronage. It has been a pleasure to serve you and we sincerely hope our service will continue to your satisfaction through the years.

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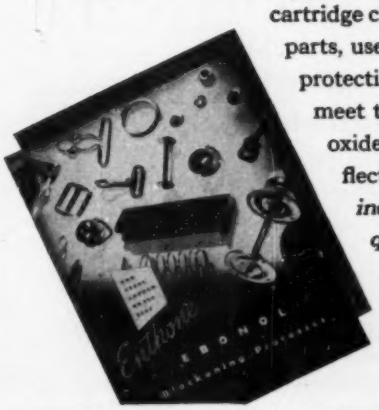
ammunition shells, cartridge clips, shoe eyelets, buckles, buttons, harness hardware, radar parts, used in World War II, received these government-approved, protective black finishes. Enthone Ebonol blackening processes meet today's Army, Navy and Air Force specifications for black oxide coatings on steel, copper, brass and zinc . . . for wear, reflectivity, saltspray, and weathering. NEW EBONOL Booklet *including detailed operating instructions, sent free on request. U.S. Patents*—2,364,993, 2,460,896, 2,460,898, 2,481,854. Canada, 463,852.



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442 ELM STREET NEW HAVEN CONN

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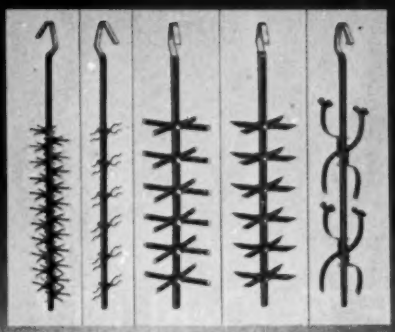
BELKE Electric Carboy Acid Pump — Transfers acids from carboys quickly and safely. Acid touches only the replaceable tube. Write for Bulletin 716R.

BELKE Current Density Meter—Hangs on cathode rod. Instrument dial shows amperes per square foot at plating surface. Write for Bulletin 439.

BELKE Permanent Tank Magnet—Recovers iron and steel pieces from bottom of plating tanks and barrels with minimum effort. Write for Bulletin 198R.



BELKE Utility Racks—*Enable you to plate more jobs without delay.* Five rack assortment efficiently handles 90% of all Plating Jobs, including bright nickel and chrome.

Removable tips and spines coated *independently* with BELKE Universal Plastic to withstand all cleaning and plating cycles. Spring pressure tips for copper-nickel-chrome service.

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BELKE Rubberite Tank Lining — Unaffected by acids and caustics at room temperature. Easy to apply. Write for Bulletin 951.

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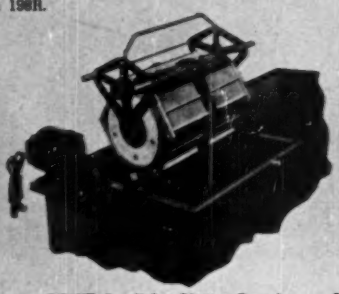

BELKE Small Lot Plating Barrels —For use with your present still plating tanks. Plates small lots efficiently and at low cost. Available in two sizes. Write for Bulletin 239JP.

BELKE Scrap Anode Baskets — Coated with Belke Universal Plastic to withstand all plating solutions. Write for Bulletin 10-BG.

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60% More Air Less H.P. Lower Cost

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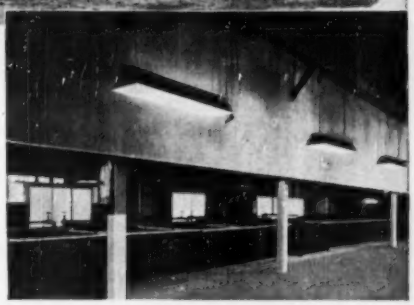
• Although a conventional duct system would have required as much as 100 H. P., this KIRK & BLUM *ductless* Fume Removal System uses just 40 H. P. to handle 160,000 cubic feet of air per minute . . . doing an excellent job of fume removal at lower initial cost and lower operating cost.

In the plant of this noted stove manufacturer, a battery of ten 8-foot tanks are ventilated by the fume exhaust system shown. Flexibility of capacity is obtained by operation of one or more fans as production requires. Even when baskets containing the parts are lifted from the tanks, the system easily removes all steam and fumes.



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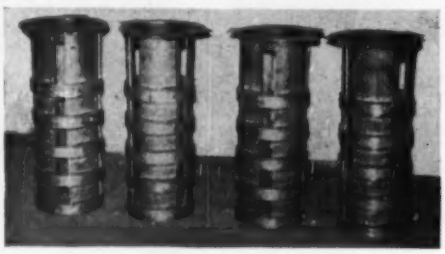

WHEN ANODES of conventional shape do not furnish the proper current distribution, STORTS fabricates special shapes for the job. An example is the group of round anodes illustrated. STORTS makes other types of specials for round work—also standard shapes—in steel and in lead. Let us take over your anode problems.

42 STONE STREET — STORTS WELDING COMPANY INCORPORATED — MERIDEN, CONN.

Manufacturers of Welded Fabrications to Specification

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 1195.

Industry News

Formation of Blake Paint Corporation was announced recently by its President, Dudley B. Blake, former General Sales Manager of United Lacquer Manufacturing Corporation. Offices are at 103 East 125th St., New York, N. Y. Organized to supply industrial finishes, Mr. Blake stated that "personalized service" would be rendered to manufacturers of metal, wood, and plastic items who use lacquers, synthetics, enamels, varnishes, thinners, wrinkle and hammer finishes, and vinyl coatings.

More Zinc. The September issue of the Horse Head Bulletin published by The New Jersey Zinc Company deals with some of the Company's activities in developing additional sources of zinc ore for the future and in improving the recovery from such ores. It is of particular interest now when much is being written about America having become a "have not" nation.

Nation's First Industrial Research Laboratory Celebrates Golden Anniversary. "Scientific research is tied more tightly than ever before to the lives and fortunes of the general public", said Charles E. Wilson, president of the General Electric Company, when he spoke on October 9 at Schenectady in ceremonies dedicating the new quarters of the company's Research Laboratory, founded 50 years ago. The General Electric Research Laboratory was established when company officials recognized that they should provide some new source of fundamental scientific knowledge which could be applied to make the technology of the future, particularly as it concerned the electrical industry. The idea of a commercial firm engaging in fundamental research was then a novel one, as it had previously been done almost solely by academic scientists.

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ABBOTT

Industry News

Dr. Whitney, a brilliant young chemist at the Massachusetts Institute of Technology, was selected to head the new laboratory. He started in an old barn in Schenectady in October, 1900. At first he gave it only half his time and had one assistant, Tom Dempster, who was also present at the anniversary exercises.

From this small beginning has come the present laboratory, still devoted primarily to fundamental research. It now has a staff of over 800. About a quarter are scientists, while the rest provide technical, clerical and other assistance.

Chromic Acid Manufacture. Diamond Alkali Company has purchased the chromic acid business of the E. I. duPont de Nemours & Company. The product will continue to be manufactured at the Philadelphia plant, and under the terms of the sale, Diamond will take over distribution of the product on January 1, 1951.

DuPont is one of three chromic acid producers in the United States. It has been in this business approximately 15 years and holds a large share of the national market for the product which is estimated at 20,000,000 pounds annually. The chromium plating field, primarily through the demand from the automotive and appliance industries, is the principal customer for chromic acid, although applications of the chemical are ever-broadening.

For Diamond, entering into the chromic acid business represents a logical diversification of its line of chromium chemicals. Diamond is a major manufacturer of sodium bichromate, an essential raw material used in the manufacture of chromic acid, and has facilities located at both Kearny, N. J., and Painesville, Ohio. Nearing completion at both these units is a rehabilitation, modernization, and expansion program costing in excess of $5,000,000.

Pennsalt Opens New West Coast Office at Berkeley. The Pennsylvania Salt Manufacturing Company has opened a new sales office in the Woolsey Building, 2168 Shattuck Avenue, Berkeley, Calif. Among those making their headquarters at the new office will be R. A. Snyder,

SALESMAN

Manufacturer with a complete line of buffing compounds and buffs has an opening for a live-wire salesman with experience and a following in the New England Territory. Knowledge and experience in Buffing, Polishing and Grinding is essential. Attractive salary plus commission.

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A PAMPHLET containing information on the properties of NIALK TRICHLORethylene is available on request. Just send in the coupon below. *Trade-Mark

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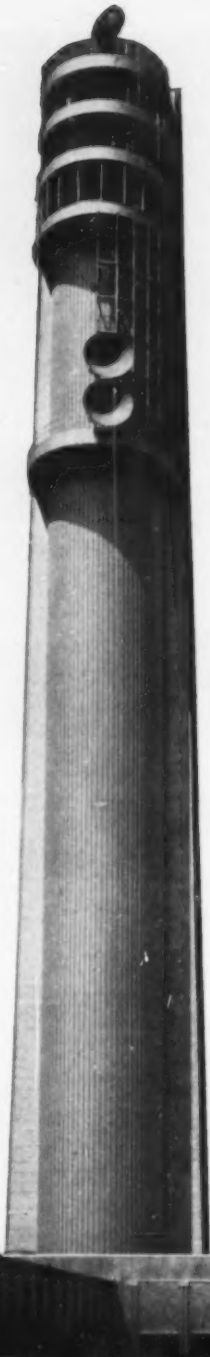

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Federal Telephone and Radio Corporation, the oldest and largest manufacturer of Selenium Rectifiers in the United States, devotes much of its tremendous plant and laboratory equipment and technical skill to the search for new ways and methods to serve business and industry. You users of Federal Selenium-on-aluminum Rectifiers in the giant electroplating industry profit through Federal's higher current overload capacities, efficiency, adaptability to varied atmospheric conditions, unique compactness and light weight. And, of course, where "time out" for adjustments often means a costly disaster, Federal offers *dependable* service and silent, unattended operation.

Illustrated is the 36-plate heavy duty stack supplied for use in the Wagner-Tiedeman Standard Electroplating Rectifier.

SOARING above the Federal Telecommunication Laboratories at Nutley, N.J., is the Microwave Research Tower housing nine laboratories of its own. In height it is the equivalent of a modern 32-story office building. The laboratories proper have a floor area of 138,000 square feet. Added to Federal's adjacent Clifton production plant, which includes the Selenium-Intelin Division, they bring the total working space to more than a million square feet.

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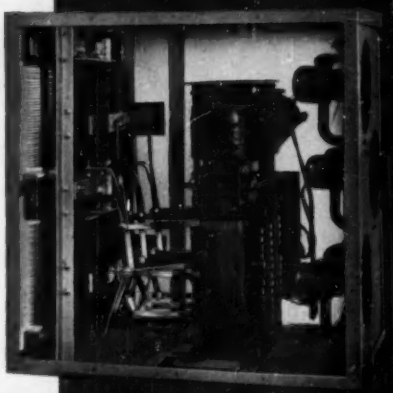
POWER RECTIFICATION

The Wagner-Tiedeman Electroplating Rectifier, a product of Wagner Brothers, Incorporated, is built around one sound policy: every claim, all ratings *must be conservative.* The company's development and production staff is proud of the W-T reputation as rugged, *trouble-free* equipment. The confidence of hundreds of critical plating men and plant engineers now depending on W-T Rectifiers as their source of DC power was won with *performance plus*—not with words.



Rear view, showing simplicity and ease of access

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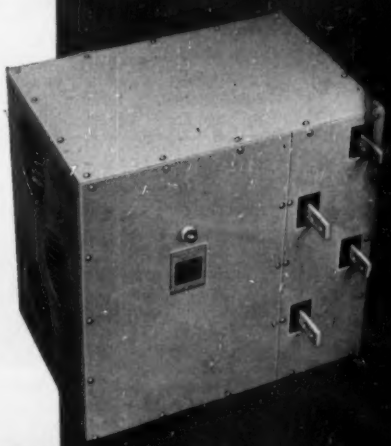

Our customers will tell you about W-T efficiency, flexibility, space-saving and trouble-free performance. Of course, the Selenium-on-aluminum stacks, made to Wagner-Tiedeman specifications by Federal, are the heart of the rectifier, selected as a result of continuous tests of all makes and years of confidence in Federal's ability to build a product satisfactory to the most critical Wagner customer.

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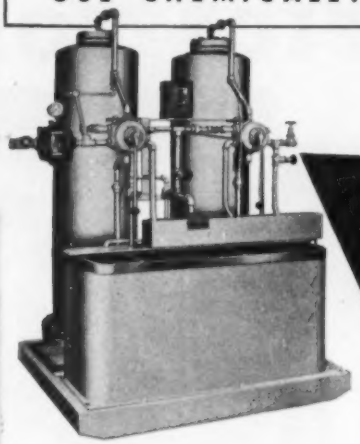

only a few cents a thousand gallons *with* . . . .

INDUSTRIAL Water Demineralizers

A Two-Bed INDUSTRIAL Water Demineralizer. Standard two- and four-bed units available with capacities of 200 to 1000 gph. Special units of any capacity engineered to requirements.

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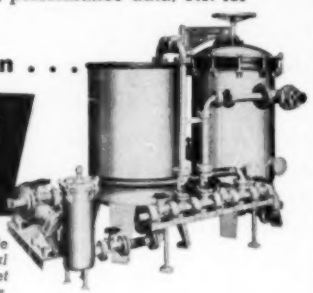

100 to 15,000 gallons per hour. Portable and stationary models. Standard or special filtration systems engineered to meet unusual requirements.

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Industry News

who will do technical sales servicework for metal and maintenance cleaners.

Mr. Snyder, a chemical engineering graduate of the University of Michigan, joined Pennsalt in 1946 and has been active in the Heavy Chemicals Sales Department at Tacoma, Wash.

G. E. Research Grants. Applications for research grants are now being accepted under the $1,000,000 General Electric Education Fund for the scholastic year 1951–1952, William W. Trench, company secretary and chairman of the General Electric Education Committee, has announced.

Under the program, now in its 27th consecutive year, up to $1,500 annually will be awarded to college graduates who wish to continue individual study and research in scientific and industrial fields.

The Fund was established in 1945, honoring two former General Electric presidents, Charles A. Coffin and Gerard Swope.

Applications for the fellowship, which must be filed by January 1, 1951, have been distributed to libraries of engineering schools, department heads of electrical and mechanical engineering schools, professors of electrical and mechanical engineering, physics, chemistry, and metallurgy, and deans of graduate schools. Applications must be mailed to the Secretary, General Electric Company Education Fund, Schenectady, N. Y.

New Field Sales Unit for Honeywell Valves. An independent field sales organization has been set up by Minneapolis-Honeywell Regulator Company for its Valve division. The nucleus of the new organization will consist of regional sales managers and a staff of upwards of twenty, who will concentrate on promoting diaphragm control valves to users, instrument and original-equipment manufacturers. The organization will provide national coverage. In addition, the company will make use in some areas of field staffs now assigned to industrial, commercial and other products of various company divisions.

PLATING FOREMAN

Chemical Engineer (Cooper Union) with graduate studies in electrochemistry seeks position. Has one year as chief chemist of plating sales and service organization with experience in solution analysis and trouble shooting, one year as trouble shooter with chemical engineering firm, and one year of supervisory work in large chemical plant. *Reply to:*

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WOW!

Eliminates expensive shop time used to bore and adjust splines

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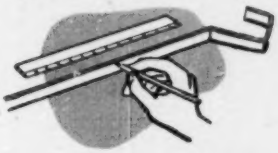
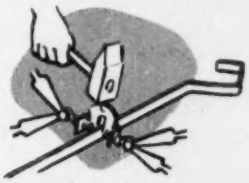


1 Measure and mark Spline



2 Drive-on STANDARD Saddle Tips *

*Patent applied for.

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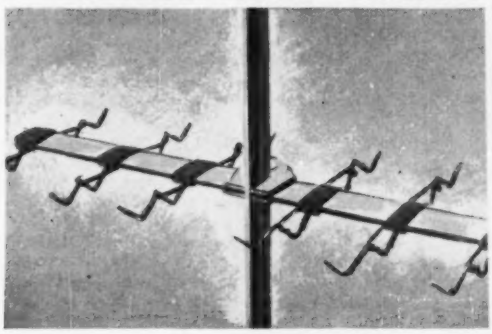

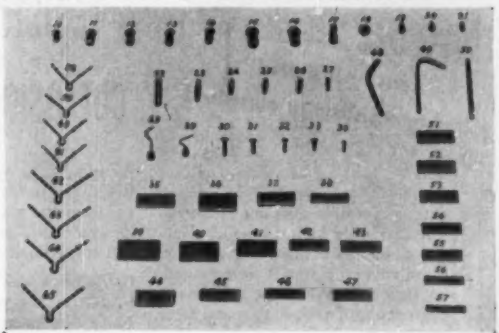

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The most modern and efficient rack producing plant in the world
WE CAN FURNISH PARTS FOR YOUR ASSEMBLY OUT OF STOCK

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easily installed!
highly resistant to abrasion!

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Personals

Robert P. Desch has joined The Atlas Mineral Products Company, Mertztown, Pa., as a Research Chemist. He graduated from Muhlenberg College receiving his B.S. degree in 1948 and a Master's degree from Williams College in 1950. He was a graduate assistant at Williams while working on his advanced degree.

Edwin C. Elliott, of Geneva, N. Y., has joined the sales staff of the Plating and Polishing Division of Frederic B. Stevens, Inc., Detroit, Mich., and will represent

Elliott

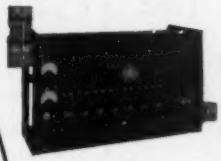
the company in New York State, with headquarters at 95 Highland Avenue, Geneva. Formerly connected with the Commercial Controls Corporation and with Geneva Forge, Inc., as plating superintendent, he has had wide experience in both manual and fullautomatic plating and polishing operations. Mr. Elliott succeeds **E. T. "Eddie" Homan,** one of the oldest active members of the American Electroplaters' Society, a charter member of its Philadelphia Branch, and widely known throughout the industry. Up to the time of his retirement, Mr. Homan had for many years covered the New Jersey, New York and part of the Pennsylvania territory for Stevens.

Emil F. Frey, now in his thirty-fourth year with DeVilbiss Company, Toledo, Ohio, has been promoted from Assistant Sales Manager to Director of Sales Promotion and Advertising. Former Assistant Sales Manager **Henry M. Kidd** has become Sales Manager of spray equipment sales, having progressed through many steps in the sales division during his sixteen years of association with the company. **John M. Ehni,** with twenty-eight years at DeVilbiss, has assumed the joint duties of Export Manager and Branch Plant Coordinator.

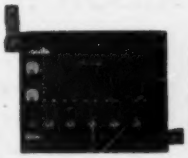
Albert H. Clem has been appointed to the newly created position of Assistant to the Vice-President in Charge of Sales of the Pennsylvania Salt Manufacturing Company. A graduate of Penn State, he joined Pennsalt in 1938 in the Research and Development Division. He later transferred to the Special Chemicals Department as Sales Service Representative

CROWN Equipment

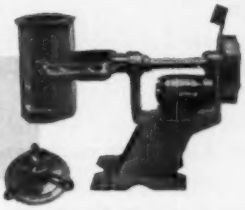
Model 815 Selenium Rectifier



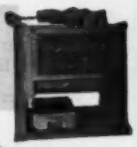
Crown Rheostat with Cut Out Switch



Crown Rheostat

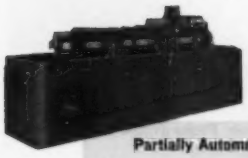


Ball Burnisher



Crown Tumble Finishing Machines

Centrifugal Drier



Partially Automatic

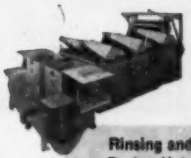
Fully Automatic Plating Machines

Crown Reversing Switch

Bottle Type Tumble Finishing Machine

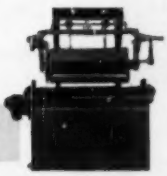
Bench Type Utility Plater

Tilting Type Tumbler



Rinsing and Drying Unit

Crown Disconnect Switch



Plating Barrel

CROWN RHEOSTAT AND SUPPLY COMPANY

3465 NORTH KIMBALL AVENUE • CHICAGO 18, ILLINOIS

MECHANIZE YOUR PLATING DEPARTMENT

ELIMINATE REJECTS • IMPROVE QUALITY • REDUCE COSTS

USE OUR
Technical Consulting
Service

●

HARRISON & COMPANY, Inc.

Twenty-Seven Years
of
Service — Quality — Price

4A

For Free Technical Consulting Service, pertaining to Polishing and Buffing

Write for complete information

A Complete Line of Compounds Tailor-made to suit your particular requirements.

HARRISON & COMPANY, Inc.
HAVERHILL, MASSACHUSETTS

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 1205.

CHROMIC ACID

99.75% PURE

POTASSIUM BICHROMATE
•
SODIUM BICHROMATE

SINCE 1845 MUTUAL CHEMICAL COMPANY OF AMERICA

270 Madison Avenue, New York 16, N. Y.

Personals

in the Detroit area and was subsequently Product Supervisor of Pennsalt cleaners before becoming Assistant Manager of the department.

Horace F. McIntyre, formerly Philadelphia District Sales Manager for the Special Chemicals Department, has been appointed Product Supervisor in that department. He joined Pennsalt in 1943. **John M. Davidson,** formerly a Sales Service Representative in the Pittsburgh district, became Philadelphia District Sales Manager. He has been with the company since 1946.

Peter M. Rusnak has been appointed a Technical Sales Representative for Standard Varnish Works, New York. A gradu-

Rusnak

ate of Brooklyn Polytechnical Institute, he has been active in the industrial-finishes field for more than fifteen years in the Eastern Pennsylvania-Southern New Jersey territories.

G. E. Verstegen has been appointed Equipment Sales Engineer by The Hanson-Van Winkle-Munning Company, Matawan, N. J. He attended the Universities of Buffalo and Michigan where he studied mechanical and hydraulic engineering and

Verstegen

has had wide experience in the design and engineering of hydraulic equipment, including die-casting machinery. For Hanson-Van Winkle-Munning he will specialize on full and semi-automatic conveyors, with headquarters in the Chicago office of the Company.

Ben P. Sax, President of American Buff Company, Chicago, Ill., on September 30 was appointed and commissioned an Aide-de-camp on the staff of Governor Earle C. Clements of Kentucky with the rank and grade of Colonel. The document, signed and sealed, now occupies a place of honor in his office.

Federated ANODES

for the Plating Trade

COPPER Anodes . . . M-Sterling Chill-formed in flat, oval, wedge, and ball shapes. Open mold shapes also available. All of prime electrolytic copper.

COPPER Anodes . . . electro-deposited, in all standard sizes . . . special sizes to order.

LEAD Anodes . . . the M-Sterling Dated Conducta-Core Anode with specially designed strong hooks coated to protect against acid fumes and spray.

TIN Anodes . . . flat and oval shapes . . . all standard sizes . . . made only of extra high purity tin.

ZINC Anodes . . . only of Special High Grade zinc in all standard sizes and shapes.

BRASS Anodes . . . full range of analyses . . . flat, oval, wedge, and ball shapes.

Federated Anodes are sold through offices in 22 principal cities. Quality is continuously controlled by Federated metallurgists so that the anodes are free of gates, flash, and cavities . . . of high chemical purity . . . to give uniform plating performance.

Federated first in the non ferrous field FMD

Write, wire, or phone for complete information

Federated Metals Division

American Smelting and Refining Company, 120 Broadway, New York 5, New York

New BURNEK
best for your barrels

BURNEK* is Wyandotte's new burnishing compound. Burnek is ideal for brass, copper, nickel, silver and gold. And it's useful for some operations on aluminum and its alloys, zinc, steel and stainless steel.

Try Burnek for barrel finishing with steel balls or shapes, small burnishing stones or chips, or self-tumbling. Your Wyandotte Representative will be glad to recommend the proper concentrations.

*Trade-mark

BURNEK *for barrel burnishing brass, copper, gold, nickel and silver and some operations on aluminum, steel, stainless and zinc*

- produces high luster fast
- rinses freely
- dissolves quickly and completely
- lowers unit cost
- reduces running time
- maintains true metallic color
- performs well in hard or soft water
- insures uniform results
- permits storage of steel media in solution

THE WYANDOTTE LINE—products for burnishing and burring, vat, electro, steam gun, washing machine and emulsion cleaning, paint stripping, acid pickling, related surface treatments and spray booth compounds. An all-purpose floor absorbent: Zorball—**in fact, specialized products for every cleaning need.**

Wyandotte Chemicals Corporation
WYANDOTTE, MICHIGAN

Service Representatives in 88 Cities

Wyandotte
REG. U. S. PAT. OFF.

Trade Literature

L—526. Plating Automatics—A 12-page, 2-color booklet, published by The Udylite Corporation, Detroit 11, Mich., illustrates and describes the complete line of Udylite Full-Automatics: single-row, double-row, overhead return-type, rotary, and other models, as well as the Udylite Junior and the Udylite Semi-Automatic. Brief descriptions of these units are given along with an outline of the Udylite service policy and pertinent information concerning the construction of Udylite machines. For your copy, use Reader Service Card.

L—527. Filters for Plating Solutions—A 4-page illustrated Bulletin 1247, issued by Belke Manufacturing Company, 947 N. Cicero Avenue, Chicago 51, Ill., gives complete information on improved Belke Filters which have a new slurry-tank design and Lucite filter plates. Information on Type-A filters for acid solutions and Type-C filters for cyanide solutions is included. Both horizontal-plate and vertical-plate models are described. For your copy, use Reader Service Card.

L—528. Polyethylene Drum and Crock Liner—Enley Products, Inc., 254 Pearl Street, New York 7, N. Y., offers a data sheet describing its liners. Features include the inertness of polyethylene, electronic sealing, round-contour bottoms, double bottoms and rims. Special liners are made from polytrifluorochloroethylene. For your copy, use Reader Service Card.

L—529. Corrosion-Protective Coatings—Anti-corrosion coatings for metal are described in a 32-page illustrated catalog, "3M Adhesives, Sealers and Coatings", available from Minnesota Mining & Manufacturing Company, 900 Fauquier Street, St. Paul 6, Minn.

The coatings protect metal against acids, chemical fumes, solvents, high humidity, and salt or fresh water, the booklet reports. They are sprayable and air-drying. The coatings include 15 "Coro-Gard" protective-coating systems and five other materials.

The catalog tabulates the properties of over 100 industrial adhesives, coatings and sealers, cites the availability of over 1,000 formulas, and offers research help for industrial customers in selecting the right product for the job. For your copy, use Reader Service Card.

L—530. Polishing and Buffing Compounds—Publication of a new illustrated 12-page catalog No. 50 covering its complete line of polishing and buffing com-

CIRCULAR CHROME PLATER

SPECIFICATIONS

- Cathode Wheel Diameter 30"; 31 Fingers, 3" Centers
- Effective Plating Travel 60"; No-plate Travel 12"
- Anode Rods 26" I.D.; 38" O.D., ½" Diameter
- Center of Anode to Center of Cathode 3"
- Tank Diameter 46"; Depth 12"
- Solution Capacity 72 gals., 2" from Top
- Anodes Used 20; ¼" x 2" x 6"
- Heating: ¾" I.D. 6% Antimony Lead Steam Coil
- Motor ¼ H.P., A.C., Variable Speed Reduction

Top quality chrome plating with continuously moving cathode — Lasalco's newest development — gives you these production-boosting, cost-reducing, profit-making advantages:

- ★ **Minimum labor — only one operator to load**
- ★ **Completely automatic unloading**
- ★ **No racks or rack maintenance necessary**
- ★ **More uniform plating means fewer rejects**
- ★ **Machine is complete, ready to install. Only exhaust and electrical connections needed**
- ★ **Far greater output — 4278 pieces per hour at 16 second plating time; 2139 pieces at 32 seconds; 1173 pieces at 55 seconds**

It will pay you to learn more about Lasalco's Circular Chrome Plater and what it can do for you.

WRITE FOR DETAILS TODAY

LASALCO, INC.

2818-38 LASALLE ST. GRand 2990 ST. LOUIS 4, MISSOURI

3M Abrasives save time and labor by polishing flat sheets prior to forming and plating

Automotive manufacturers and suppliers have substantially reduced the cost of preparing metals for plating, with this new "pre-polishing" method. Flat sheets of steel are passed under a series of grinding and polishing heads where progressively finer grits of abrasive belts automatically produce surfaces conditioned for plating. These operations are being performed at speeds up to 40 feet per minute.

This means that pits, seams, slivers and other surface imperfections are removed while the steel is in sheet, coil, or blank . . . the most economical forms to handle.

Users report that "pre-polishing" minimizes die strain while cutting finishing and handling costs. If you manufacture products that require polishing before plating, it'll pay you to investigate this new development. Send for our bulletin on "pre-polishing" . . . see coupon on this page.

Send me your latest report on "pre-polishing"

PL-1250

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Department_____

Firm Name_____

Street Address_____

City_____ State_____

Made in U.S.A. by Minnesota Mining & Mfg. Co., St. Paul 6, Minn., also makers of "Scotch" Brand Pressure-sensitive Tapes, "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-Slip Surfacing, "3M" Adhesives. *General Export:* Durex Abrasives Corp., *New Rochelle N. Y. In Canada:* Canadian Durex Abrasives Ltd., *Brantford, Ontario.*

Trade Literature

pounds is announced by Frederic B. Stevens, Inc., Detroit 16, Mich.

The catalog describes Stevens' many compositions for every metal surface and for every polishing and buffing operation. In addition, it outlines Stevens' customer services and offers recommendations for the type of composition to use for each operation. For your copy, use Reader Service Card.

L—531. Polishing and Buffing Supplies — Schaffner Manufacturing Company, Schaffner Building, Emsworth, Pittsburgh 2, Pa., has announced the release of a new Catalogue No. 51 containing the latest methods of polishing, buffing and coloring, as well as complete speed charts for buffing wheels and charts designating the proper composition to be used on various metals to obtain the desired finish. For your copy of this up-to-the-minute catalogue, which is also a buffing and polishing dictionary, use Reader Service Card.

L—532. Recording Instruments—A bulletin No. W1821, "Recording Chart Instruments" describing the company's new line of Series 500 Strip-Chart Dynamaster Electronic Instruments has just been published by The Bristol Company, Waterbury 20, Conn. The bulletin gives information concerning instruments for recording and indicating such variables as temperature, resistance, conductivity, strain, position, inductance, pressure and force. Pneumatic and electric-operated automatic-control models are also described. The bulletin is liberally illustrated with photos of various models, reproductions of chart records, and schematic drawings. Photographs of several interesting installations of the instruments are also included. For your copy, use Reader Service Card.

L—533. Pickling Inhibitor—A new type inhibitor, "Enthone Inhibitor 8", has been announced by Enthone, Inc., Dept. P, 442 Elm Street, New Haven, Conn. The manufacturer states that this inhibitor possesses many advantages not shared by any other inhibitor on the market: high inhibiting action in many types of mineral acids including hydrochloric, sulfuric and phosphoric acids, lack of odor, complete miscibility with pickling solutions, ease of handling, and economy of use.

The inhibiting action in hydrochloric and sulfuric acids is said to be very high, of the order of 99 per cent even at 180° F. In addition to the high inhibiting action with its attendant advantages of saving of acid, lowering attack on metal, and brighter pickling, the inhibitor lowers the surface tension of the pickling solution, which results in lowering of the drag-out. Unlike many inhibitors, Inhibitor 8 does not increase hydrogen embrittlement of steel. It has high tolerance to ferrous sulphate.

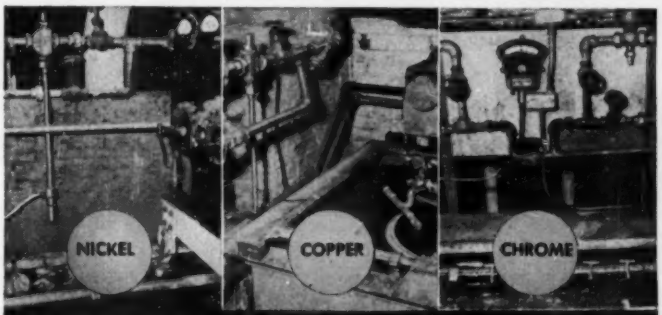
Adsorbed film of Inhibitor 8 on the work can be readily removed by means of alkali cleaners or good running rinses. Any trace of inhibitor that may remain when rinsing is not complete lowers the tendency of the steel towards rusting, which is particularly important in drying of steel on hot humid days.

The amount of inhibitor required is of the order of 0.1 to 0.2 per cent by volume of the acid mixture. For your copy of a descriptive bulletin use Reader Service Card.

L—534. Phosphate Coating Chemicals and Processes—A 12-page illustrated Technical Service Data Sheet No. P-100-46 recently issued by American Chemical Paint Company, Ambler, Pa., describes the company's many processes for bonding paint to steel, zinc and zinc-alloy; cadmium and aluminum surfaces; for rust proofing; for protection of friction surfaces; and for improving drawing and extrusion. Methods of application include spraying, dipping, and brushing. For your copy, use Reader Service Card.

L—535. Corrosion Resistant Coatings, Piping and Tubing, Linings—An 8-page illustrated bulletin, "Cyclon Corrosion Resistant Materials of Construction", just printed for Munray Products, Inc., 12500 Crossburn Avenue, Cleveland 11, Ohio, describes a variety of standard products: industrial coatings, adhesives, process-equipment linings, extrusions, chemical tubing and piping. It gives details of their physical and chemical properties and discusses applications.

Munray Products, Inc., is likewise equipped to custom-compound protective materials to meet specific requirements. For your copy, use Reader Service Card.



PRECISION PLATING

With 3 Sarco Temperature Controls

Any plating engineer knows exactly what he wants in temperatures for the various jobs going through his plant. Few realize that the very controls he needs are waiting for him and can be installed quickly at comparatively little cost.

Starting with the wash tanks he can get a suitable control in the Sarco 87 Thermoton for the cost of a good steam trap.

For greater refinements in control the Sarco TR-22 illustrated and the Sarco TR-21 control are available. For chrome he can add automatic cooling at little cost.

For most plating jobs he can keep temperatures within a degree or two with the inexpensive Sarco LSI Electric Controls.

187

SARCO SAVES STEAM

SARCO COMPANY, INC.
Empire State Building, New York 1, N. Y.
SARCO CANADA LTD. TORONTO 1, ONTARIO

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 1211.

[redacted]

from **PROMAT**

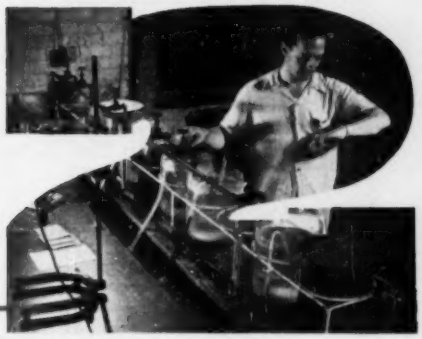
TO HELP YOU MEET TODAY'S METAL FINISHING DEMANDS

[redacted] ... Addition Agents to Improve Acid Cleaning ... Iron Sequestering Agents ... Abrasives

THE protective and/or beautifying value of a metal finish depends entirely on its adherence to the base metal. All too many finishes fail prematurely due to lack of adherence caused by faulty cleaning. NEW PROMAT ADDITION AGENTS add cleaning power to acid solutions, speed the action, insure uniform attack and retard formation of a film of iron salts on the metal surface. They are useful in all pickling operations prior to metal finishing and are recommended for use by electroplaters, hot dip galvanizers, porcelain and synthetic enamellers, etc. Use of PROMAT IRON SEQUESTERING AGENTS in the rinse water insures complete removal of the film of iron salts which inevitably forms on ferrous metals in any acid dip.

Addition of the above simple-to-use, economical chemicals to the acid dip and rinse water insures a truly clean surface to which the metal finish will adhere perfectly. The resulting improvement in appearance and quality and reduction of rejects is rapidly winning the acclaim of metal finishers handling both commercial and military work.

Another development of interest to metal finishers is the new line of PROMAT LIQUID ABRASIVES. These abrasives are entirely new, all components being exclusive developments which provide superior performance. Because these abrasives go farther, clean easier, work faster and give unusually high color, some users are now finding it profitable to equip *hand jacks* as well as automatics with liquid abrasive systems. Promat liquid abrasives are available for non-ferrous metals and stainless steel.



[redacted] ... Acid and Alkaline Zinc Baths

.. Addition Agents for Purifying, Conditioning, Brightening

ZINC platers, cadmium platers who are changing to zinc and companies doing zinc plating for military orders will all find PROMAT 99M2 ZINC ELECTROLYTE of particular interest. It is [illegible]-to-handle bath available. To each gallon of [illegible] you simply add one gallon of water and 50 c.c. of Promat C-42 Addition Agent. This bath is very economical and will outperform ordinary baths of comparable price. It can be operated at current densities as high as 200 amperes per sq. ft. without burning. The throwing power, speed and efficiency are outstanding. Fine grain structure of the electrodeposit is assured and lustre is good. This electrolyte is not designed to produce bright zinc out of the bath because brightness so produced never lasts. Where brightness is desired, Promat recommends economical secondary treatments which produce unexcelled *lasting* brightness. The combination of Promat 99M2X electrolyte and Promat brightening treatment gives high lustre *plus protection* at no greater cost than ordinary bright zinc baths. Where desired, however, Promat supplies excellent electrolytes for bright-out-of-the-bath zinc. Promat electrolytes are available for still tanks, semi or full automatic machines and barrel plating.

PROMAT DOCTOR SOLUTION. This is an exceptionally effective, economical, easy-to-use purifying agent for all cyanide zinc solutions. It is added in very small quantities to precipitate all heavy metal impurities except copper.

PROMAT C-42 ADDITION AGENT. This agent is a component part of all Promat zinc electrolytes. It permits operation over a range of from 5 to 200 amperes per sq. ft., produces an excellent fine grain semi-bright deposit. It is available for use with other baths.

[redacted] ...Secondary Chrome Film Treatments for Increasing Corrosion Resistance of Zinc, for Producing Long-Lasting Bright Zinc, for Making Zinc Readily Paintable

THE line of Promat protective coatings for zinc surfaces represents a long research program into the subject of chrome films. The result is a complete line of products including: the lowest cost chrome finish ever offered; the brightest, longest-lasting finish available; an olive drab variety with new characteristics of appearance and protection, and a series of other protective coatings for electro-plated and hot dip zinc and zinc base die castings.

All of these Promat protective coatings are secondary treatments applied by simple immersion of the already-plated work. All provide a superior product for the user; with them any specifications or inspections for commercial or military work can be met. In the long run they cost less and provide unexcelled quality of finish.

For a complete discussion of any Promat product, write, or phone today.

[redacted] Poor & Company

851 South Market Street • Waukegan, Illinois

Distributors in Principal Cities

Equipment and Supplies

E—595. Multi-Combination Meter for Electrolysis and Corrosion Testing—A new model, the B-3, of the Multi-Combination Meter for electrolysis, corrosion and cathodic-protection testing, is now available from the manufacturer, M. C. Miller, 1142 Emerson Ave., West Englewood, N. J. It is small, compact and low-priced compared to the previous Model 5. The accuracy is 1 per cent.

With this Multi-Combination meter, practically all measurements encountered in electrolysis and corrosion investigations by cathodic-protection testing in field and laboratory can be made. By use of a circuit selector switch, the two high-sensitivity d-c instruments can be connected into a variety of measuring circuits for measurement of a wide range of potentials, current, resistance, and soil resistivity. For further information, use Reader Service Card.

E—596. "Karbate" Globe Valves—Said to be an outstanding feature of "Karbate" impervious-graphite globe valves, manufactured by National Carbon Division, Union Carbide and Carbon

Corporation, 30 E. 42nd Street, New York 17, N. Y., is the self-lubricating, corrosion-resistant threads on the bonnet and spindle.

The photograph is an untouched picture of the spindle from a 1-inch valve that has been in continuous service for over two years. This valve was used to fill carboys from a sulfuric acid storage tank and was therefore subjected to complete opening and closing a number of times each day. The spindle threads show a very slight rounding but are still in excellent condition. The disc on the spindle has worn exactly as expected and continues to re-seat itself. For further information, use Reader Service Card.

E—597. Conversion of Tanks to Diaphragm Plating—Automotive Rubber Company, Inc., 8601 Epworth Boulevard, Detroit 4, Mich., working in conjunction with some of the country's leading plating engineers, has designed a conversion unit which can be installed in tanks where the size of the work permits, without major expenditure.

Diaphragm plating provides for the segregation of anode and cathode compartments by means of canvas-duck screens. The anode solution is pumped off, filtered, and passed to the cathode compartment free of insolubles and organics which form at the anode and ordinarily deposit on the work pieces. The result is smoother deposits at higher current densities.

The conversion unit consists of fabric sleeves that slide on rubber-insulated metal frames which in turn slide into insulated channels with the cathode side of work lane protected by insulated woven-wire guards. Sections can be constructed for tanks of any width or length with single or multiple work lanes. For further information, use Reader Service Card.

E—598. Lead Anodes—The Division Lead Company, 832 Kinzie Street, Chicago 22, Ill., now offers a new feature on its 71-Point Lead Anodes, a corrosion-proof plastic coating, "Black Armor", to protect the hooks from chromic acid fumes, dragout drippings, and spray. The coatings are said to add materially to the service life of these high-conductivity copper hooks, making them last several times as long by actual test. Increased ease of handling is still another

Put Your FINISHING PROBLEMS IN A HENDERSON TUMBLING BARREL

For nearly ¾ of a century HENDERSON BROS. has been helping manufacturers solve their Tumble Finishing problems with a wide variety of Tumbling Barrels . . . Sided Wood Barrels, Round Wood Barrels, Perforated, Cast Brass, Cast Iron, Welded Steel Barrels and Rubber Lined Barrels in the Tilt type and Horizontal Type for Bench and Floor installations. Where special processes call for special barrels, Hendersons is prepared to design and construct Tumbling Equipment to customer specification.

Write us, outlining your particular problem. Our Engineering and Development Service will be glad to make recommendations.

Since 1880 Designers and Builders of Tumbling Barrel Equipment.

THE HENDERSON BROS. COMPANY
137 SOUTH LEONARD ST. WATERBURY 85, CONN.

Now! A DIVCO PLUS Feature at NO COST TO YOU!

"BLACK ARMOR" HOOKS

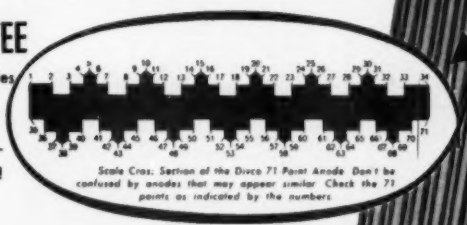
Make DIVCO 71 Point LEAD ANODES Last Longer!

* plastic coating is cut away by user only at point of contact.

Corrosion of anode hooks has long been a plating problem, since these hooks are constantly exposed to chromic acid fumes, dragout drippings, and spray. Now, DIVCO'S "Black Armor" plastic coating over the high conductivity copper hook eliminates the problem of premature anode failure due to hook corrosion. "Black Armor" as the name implies actually is the toughest corrosion resistant coating tested and found suitable by DIVCO'S Laboratory. This adds tremendously to the service life of the hooks *and* to ease of handling as well—*at no increase in price!* Again, DIVCO offers another contribution to plating efficiency . . . and *only* DIVCO offers this added advantage without additional cost!

MONEY BACK GUARANTEE

Equip your tank with 71-Point Lead Anodes for a trial period. If Divco doesn't do more than any lead anode you've ever used, we'll return every penny you paid—and thank you for telling us about it, too!



Scale Cross Section of the Divco 71 Point Anode. Don't be confused by anodes that may appear similar. Check the 71 points as indicated by the numbers.

AVOID SUBSTITUTES

Look for DIVCO beneath the hook or count the 71 edges

Please specify bus bar size and distance from top of bus bar to bottom of anode.

FREIGHT ALLOWED — on orders of $100.00 or more — to any destination in the U. S., or to point of border crossing or embarkation on export shipments.

A GOOD NAME CARRIES WEIGHT

DIVISION Lead COMPANY

832 W. KINZIE ST., CHICAGO 22, ILL.

Other DIVCO Products:

LEAD SHEET • PIPE • WIRE • FOIL BURNING & FABRICATION

LEAD LINED TANKS • LEAD STEAM COILS

CONFORMING ANODES •

ANODES OF ALL METALS

Half of this message has to do with FLUID-FILM —the all-purpose die lubricant for deep drawing which is:

. . . a non-pigment, semi-emulsion
. . . non-corrosive to die or metal
. . . applied by brush, roller, dip or spray
. . . readily cleanable

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the other
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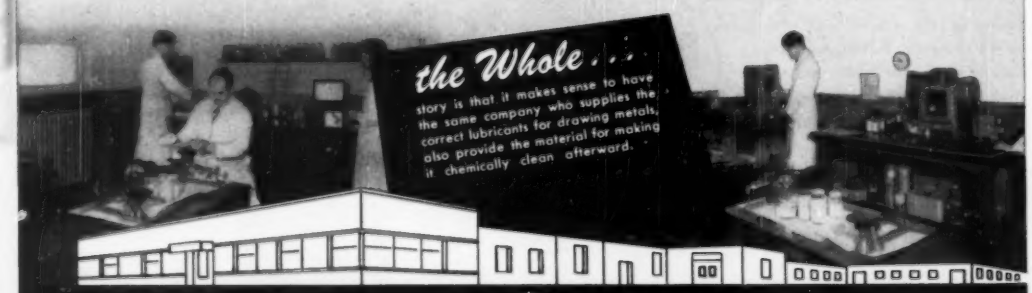
the Whole . . .
story is that it makes sense to have the same company who supplies the correct lubricants for drawing metals, also provide the material for making it chemically clean afterward.

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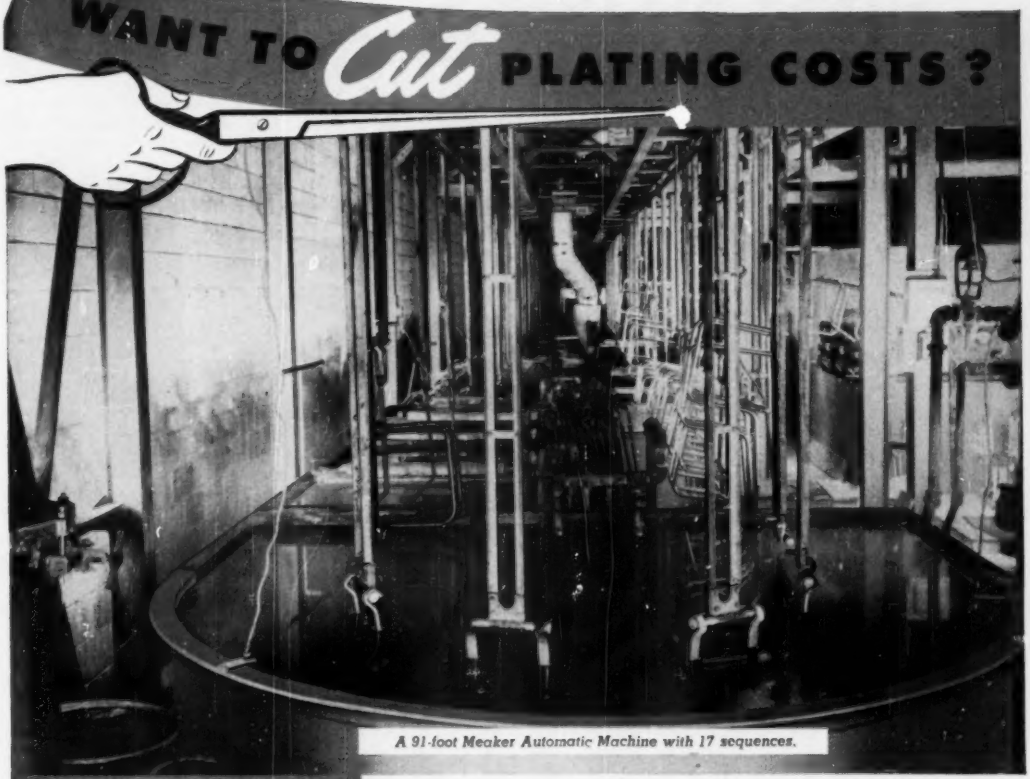

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Equipment and Supplies

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E—599. All-Plastic Safety Goggle—The all-plastic safety goggle, "Saf-I-Duo", manufactured by the United States Safety Service Company, Kansas City 6, Mo., is said to have several unique features: removable and interchangeable

one-piece plastic lens which will fit also the "Saf-I-Spec", an all-plastic safety spectacle; lens made from Optilite, a safety plastic which meets government specifications for optical qualities and impact resistance; lens in clear or anti-glare green; goggle frame made of soft Vinyl, firm, yet pliable enough to effect a tight seal against the face; will fit over personal glasses; has light weight and attractive appearance. For further information, use Reader Service Card.

E—600. Water Demineralizer with Flow Meter—The Penfield Manufacturing Company, 19 High School Avenue, Meriden, Conn., has announced a new Ion Exchange Demineralizer for laboratories and other users of up to 10 gallons per hour of high-purity demineralized water. Designed to attach to any wall near a tap, the new Penfield Demineralizer has a permanent cartridge for replaceable resin and is equipped with a flow meter that enables the operator to adjust flow intake to the proper rate for most efficient results. An electric conductivity meter built into the unit provides a continuous, visual indication of the quality of the treated water, warning when the resin charge should be renewed. For further information, use Reader Service Card.

E—601. Aluminum Anodizing Process—A newly developed tank for anodizing aluminum, constructed to give continuous service for three years under normal operations, is announced by the F. H. Langsenkamp Company, 227 E. South Street, Indianapolis, Ind. Reinforced within itself (welds at all four corners overlap), the tank is available in all sizes, in stainless steel, aluminum, or copper. For further information, use Reader Service Card.

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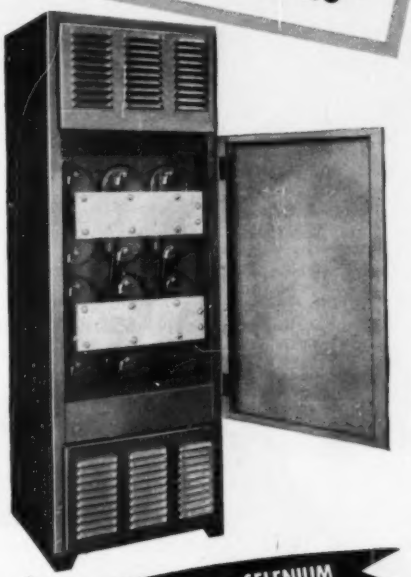
Greater efficiency at plating currents and less change in characteristics with aging has made copper-oxide one of the most popular of all plating rectifiers. These two features—which mean lower power costs over more years of service—continue to make copper-oxide the top choice for heavy-duty operations, particularly in automatic plating installations.

G-E copper-oxide rectifiers are available with either automatic or manual control. For the ultimate in uniform plating, predictable plating costs and minimum labor, G.E.'s automatic system is your choice. For dependable plating current—with simple, convenient, "at-the-load" current control which is moderate in initial cost—use G-E manually controlled copper-oxide rectifiers.

For complete details, write for Bulletin GEA-5247.



OIL-IMMERSED SELENIUM

General Electric's new oil-immersed selenium rectifiers have been especially designed to operate in corrosive or dusty, linty atmospheres. Rectifier stacks are hermetically sealed in welded, oil-filled cans—can be installed right next to your tank and still give long dependable service. This new selenium rectifier is ideal for barrel plating, too. The high thermal capacity of its oil, plus improved ventilation, enable this rectifier to withstand brief current fluctuations with safety.

Lower initial cost is the third important feature of oil-immersed selenium—and will often outweigh the somewhat higher efficiency of copper-oxide when power costs are not a controlling factor.

For complete details, write for Bulletin GEA-5519.

For application information, call your General Electric Apparatus Department Sales Representative or authorized G-E Agent. *Apparatus Department, General Electric Co., Schenectady 5, N. Y.*

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464-5

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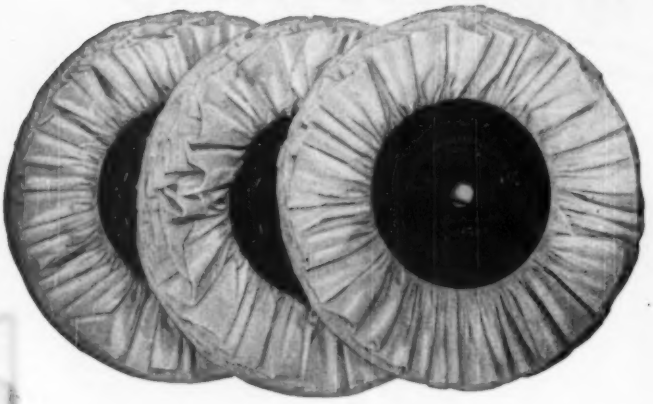

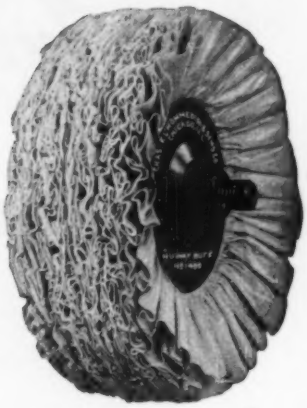

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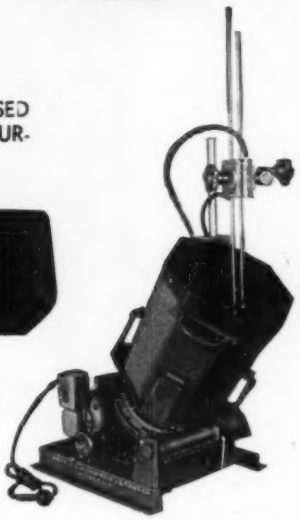

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THE MAILBOX

Subject: Conservation

DEAR SIR:

Reference is made to the October editorial by Mr. C. F. Nixon. I have read, reread, and then come back and read it again. It gives a clear insight into some of the reasons why Clyde Kelly and Cleve Nixon are two of our outstanding platers.

Whereas the editorial was titled "Nickel Conservation" and enumerated ways of saving nickel, the wording would have to be changed very little to make it a treatise on the saving of zinc, cadmium, chromium, or tin, and thus it is valuable to all platers.

Nothing new, profound, or revolutionary is proposed. Instead we find a reaffirmation, in language so simple that even the shop sweeper could understand it, of the fundamental principles which are apparent in a well-functioning plating operation. But fundamentals are things which are too often taken for granted, and they are frequently overlooked when troubles come along.

Timely for nickel conservation, Mr. Nixon's editorial is timeless as a guide to good plating practice.

Sincerely,
S. S. JOHNSTON

Subject: Specifications for Gold Electroplates

DEAR SIR:

Here is a double $64.00 question. We are gold plating 18 per cent nickel silver. The plating operations are cyanide-copper flash (20 seconds), bright nickel (60 seconds), gold plate (20 seconds), more or less.

The gold solution contains copper, nickel and gold—so does the deposited metal.

How can the thickness of the gold deposit be obtained? How can the karat of the deposit be determined?

The proposed Federal Specifications call for a definite thickness of gold and a deposit of about 10 karat.

I agree with Dr. Louis Weisberg that this is a problem for research.

Sincerely,
GEORGE B. HOGABOOM

Subject: Drag-in

DEAR SIR:

Mr. Pinkerton is a good mathematical detective. The exact equation 5, which was derived by this writer some fifteen years ago in connection with a problem in dragout recovery and published in Metal Industry (N. Y.), January, 1935, cannot be approximated by the suggested simplified equation 6 when t, the time, becomes very large.

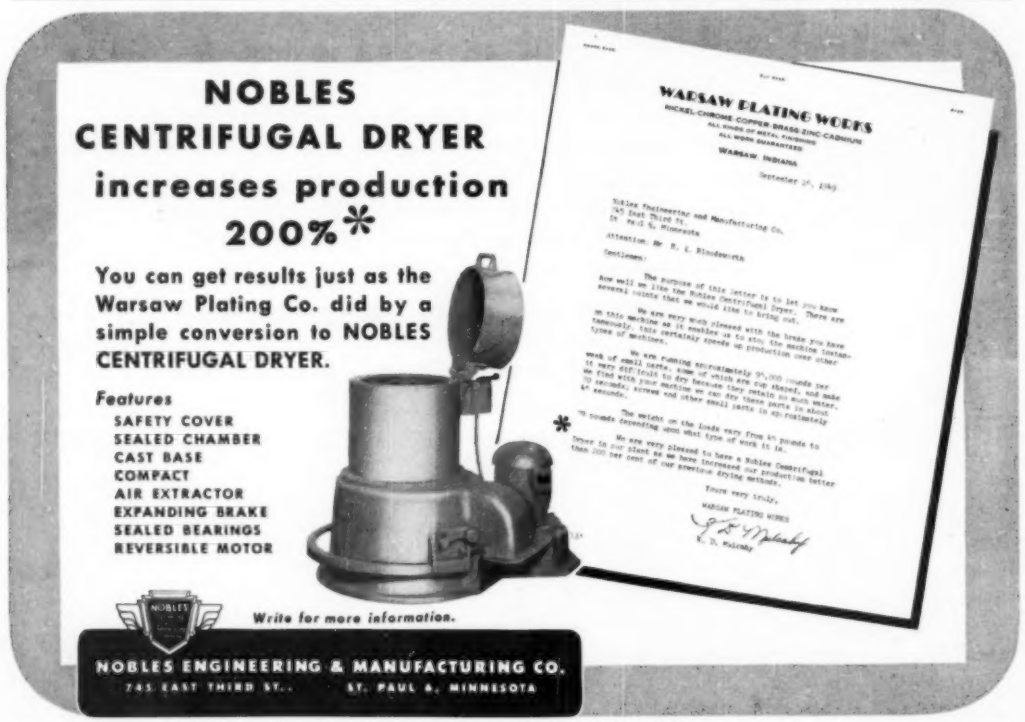
The relationship between equations 5 and 6 can be readily seen from the enclosed diagram. In most cases, the dangerous threshold concentration of the contaminant in the plating bath will be quite low, and trouble will start well before the straight line and the curve part company. This being so, the approximate equation 6 can be used safely. However, where very long periods of time are involved, the exact equation should be used.

For those who do not like to work with logarithms, the following approximation of equation 5, which is valid for both large and small values of t, is suggested:

$$C_p = C_1 (1 - e^{-\Phi nt/V_D}) \qquad (5A)$$

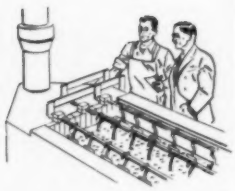
All that is needed to work it is a table of exponentials. In the example proposed by Pinkerton where $t = 100{,}000$ minutes, both 5 and 5A give $C_p = 0.865\ C_1$.

Sincerely yours,
JOSEPH B. KUSHNER



News about UNICHROME Trade Mark COATINGS for METALS

METALLIC ORGANIC DECORATIVE PROTECTIVE



What! HIGH SPEED chromium plating?

The most important advance in chromium plating in 20 years, Unichrome S.R.H.S. Chromium plates faster than conventional solutions – in some cases cutting time in half. It also plates bright over a wider current range – assuring less "burning" and "missing" on irregular parts. Its self-regulation insures good throwing power and provides a more foolproof bath with less supervision.

Avoiding needless waste

Using Unichrome Coating 218X to insulate plating racks cuts waste. It lasts longer in all baths, thus reducing wasteful depositing of metal on the rack. It rinses freely, thereby minimizing loss of valuable plating salts by "drag out."

Less buffing for copper plate

Without using brighteners, Unichrome Pyrophosphate Copper deposits a s-m-o-o-t-h plate. If needed at all, buffing of this ductile copper takes less time and effort.

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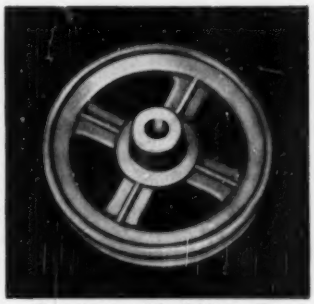
Extra bright, durable finish on zinc plate...
Extra corrosion-resistance for zinc die castings...
provided at a low, low cost by **UNICHROME DIP PROCESS**

Sparkling rust resistance at low cost for wire goods and small parts obtained with zinc plate and Unichrome Dip.



Chromate treated in Unichrome Dip, zinc die cast parts resist corrosion with a yellowish to olive drab finish.

Zinc plate followed by the Unichrome Dip process works wonders on sales appeal and finishing costs. The ordinary zinc gains chromium-like brightness. Some users have reported it the brightest dip finish they've *ever* seen. And it stays bright. For Unichrome Dip Finish adds corrosion-resistance – protects the zinc against dulling.

Yet this kind of finish costs you only a fraction of a penny per square foot of average zinc surface treated. Therefore, you can see why Unichrome Dip Finish is being used extensively on zinc die castings, refrigerator shelves, wire goods, screws, nuts, bolts and other parts.

The Unichrome Dip process is a chemical treatment. The finish it forms is integral with the zinc surface. It can also be used to chromate-treat unplated zinc die castings. Such chromate treating produces a yellow or olive drab coating with corrosion-resistance even greater than that obtained with the bright finish–again at rock-bottom cost.

We'll gladly send you more information on Unichrome Dips. And remember, if you have a problem in metal finishing, chances are you can find a solution at "Coatings for Metals" headquarters.

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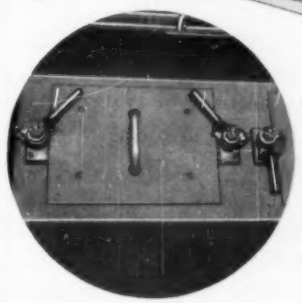
MODEL 48-2



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The cover picture shows an RCA Electron Microscope with the cover removed to expose some details of construction. Courtesy U. S. Rubber Company.

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PLATING is abstracted regularly in Chemical Abstracts, Engineering Index, Technical Data Digest and Bulletin Analytique.

plating

DECEMBER, 1950 VOL. 37 No. 12

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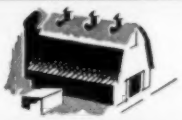

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Editorial

Tin as a Substitute for Other Plating Metals

WHEREAS MANY PLATING METALS, especially cadmium and nickel and even zinc, are in short supply, tin is still freely available. At this time there is no indication of control measures from Washington except as to inventories. The situation would, of course, change at once if the Malayan tin mines became unavailable to the Western powers.

Tin has several properties which make it useful as a substitute for zinc and cadmium in many applications, and it has even taken the place of nickel in some cases. It has a relatively high resistance to atmospheric attack, especially in protected locations. Thus in the severely industrial atmosphere of Birmingham, England, tin corroded indoors about one-quarter as much as zinc. Unlike zinc or cadmium, tin does not normally protect steel sacrificially but behaves more like nickel in that respect. Thin tin coatings are very porous in the hot-water test, but some data indicate substantial absence of porosity in coatings over 0.0006-inch thick. Tin coatings up to 0.0003-inch thick may be brightened by heat flowing. Tin coatings are highly receptive to soldering.

A zinc-tin alloy coating deposited from a stannate-cyanide bath and containing 80 per cent tin has been recommended in about equal thickness as a substitute for cadmium in the electrical industry and in marine atmospheres. It protects steel sacrificially, and like tin and zinc it can be passivated in chromate-containing dips.

A limitation to the application of tin or tin alloy from stannate baths is the larger current capacity required in comparison with cadmium for the same plate thickness.

The properties of tin and tin coatings are discussed in some detail in several books on corrosion, notably "Protective Coatings for Metals" by Burns and Schuh (Reinhold Publishing Company, New York, N. Y.) and those of zinc-tin alloys by Cuthbertson and Angles in a paper in Vol. 94 (1948) of Transactions of The Electrochemical Society. The latter also describes the bath and operating conditions. The Tin Research Institute, Inc., Columbus 1, Ohio, is a good source of information about tin.

Gustaf Soderberg

THIS STUDY

presents a comparison between the nickel fluoborate electrolyte and other types of nickel baths. The evaluation procedures employed are given, and the data presented include the buffer characteristics, resistivity, limiting current density, current efficiencies and throwing power of the solutions, as well as the physical properties of, and stress in, the nickel deposits. Information is supplied on the preparation and control of the bath.

NICKEL PLATING
from Fluoborate Solutions

CLIFFORD STRUYK and A. E. CARLSON

General Chemical Division, Allied Chemical & Dye Corporation, New York, N. Y.

INTRODUCTION

The many possibilities of fluoborate plating baths have long been recognized. However, their use was confined to laboratory investigation and research until commercial quantities of metal fluoborate solutions became available from General Chemical Division in the past few years. Today, their development has been brought to the point where fluoborate baths are finding acceptance throughout the plating field and an increasing number of installations are establishing their advantages and economies for many types of commercial operations. Data covering their properties and methods of application for specific uses are available[1-4]. The material in this paper deals with nickel fluoborate solution, which is now being used commercially for barrel plating and stereotypes. The data herein supplement the excellent work on this subject published by Roehl and Wesley[5].

The investigation of the nickel fluoborate plating bath showed it to possess the following advantages:

1. The control of the fluoborate bath is simple, involving only a gravity reading and a *p*H determination.

2. The deposits are light in color, smooth, and exhibit some luster, or sheen, over a wide range of current densities.

3. The fluoborate solution is buffered more highly than the sulfate or chloride baths. This means that the bath is extremely resistant to *p*H changes and requires less attention for control and adjustment.

4. Anode performance is excellent over a wide range of operating conditions.

5. The fluoborate solution has a relatively high tolerance for metallic impurities, apparently higher than the chloride-sulfate nickel solution.

6. The conductivity of the solution is high; about twice that of the Watts-type nickel baths and approximately equal to that of the all-chloride baths.

7. Nickel fluoborate has high solubility, allowing the use of bath concentrations far above those possible with sulfates or chlorides. This is very advantageous where extremely high plating rates are desired.

8. The bath is stable and substantially free from sludge, thus insuring better quality deposits.

9. The internal stress in deposits from the fluoborate solution is lower than in those from Watts-type nickel baths and much less than in those produced from chloride solutions.

10. The throwing power of the fluoborate bath is improved by additions of ammonium fluoborate. Such additions are not accompanied by formation of relatively poorly soluble double salts as in the case of the subfate and chloride systems.

BATH COMPOSITIONS

The baths given in Table I are typical of the solutions used. Other bath compositions above and below those given are workable. Because of the high solubility, the nickel fluoborate system is very versatile and bath compositions can be chosen to meet a variety of practical working conditions.

EVALUATION PROCEDURE

Limiting current densities were used as one basis for the determination of the optimum solution composition and operating variables. In order to establish the cathode limiting current density, the solution under study was placed in a glass cell, 5.5 cm wide

TABLE I. TYPICAL PLATING BATHS

	Low		Medium		High*	
	g/l	oz/gal	g/l	oz/gal	g/l	oz/gal
Nickel fluoborate, $Ni(BF_4)_2$	220	29.5	300	40	440	59
Nickel, Ni	55	7.4	75	10	110	14.8
Free fluoborate acid, HBF_4	4–38	0.5–5	4–38	0.5–5	4–38	0.5–5
Free boric acid, H_3BO_3	30	4	30	4	30	4
*p*H (colorimetric)	2.0–3.5		2.0–3.5		2.0–35	
Temperature, °F	100–170		100–170		100–170	

*Nickel concentrations as high as 175 g/l may be used.

by 10 cm long by 7 cm deep (about 2.2 by 4 by 2.8 inches), with a flat section of commercial nickel anode at one end. Steel panels, approximately the size of the end of the cell, were cleaned thoroughly and placed against the end of the cell opposite the anode. The panels were plated at various current densities for a period of time calculated to give a thickness of one mil (0.001 inch; 25 μ). The limiting current density was taken as the current density value at which the first burning occurred at the edges of the panel without agitation.

With the exception of the values given in the buffer curve in Fig. 1, the *p*H values given are colorimetric and were obtained by the use of *p*H papers. The electrometric *p*H value used in Fig. 1 was obtained by the use of a Beckman Industrial *p*H meter. A conventional calomel electrode was used for the Watts-type and chloride baths. Because the precipitation of potassium fluoborate at the junction of the salt bridge interfered, giving rise to erratic results in the nickel fluoborate bath, the potassium chloride junction was converted into a saturated sodium chloride junction and the instrument was standardized against buffer solutions of known *p*H. Satisfactory readings could be obtained with the apparatus.

Resistivity values were determined by means of an Industrial Instrument conductivity bridge.

In addition to the limiting current density, nickel was plated on buffed-steel and copper Hull-cell panels. Other panels of steel and copper were plated and examined for appearance and bent to determine the ductility of the deposits.

Buffer Characteristics

A series of buffer curves were obtained on the fluoborate, the all-chloride and the Watts-type nickel baths. The procedure used was as follows. Nickel carbonate was added to 800 ml of each solution under consideration for a time period sufficient to attain equilibrium. The excess nickel carbonate was filtered off, and the clear filtrate was heated to remove the carbon dioxide gas. The solution, after cooling, was placed in a beaker containing the electrodes from the *p*H meter. The initial reading was taken, and increments of 4-*N* acid were added. The solution was stirred vigorously by means of a mechanical stirrer, and after equilibrium had been reached the resultant *p*H was noted. Sulfuric acid was used for the Watts-type bath, hydrochloric acid for the all-chloride bath, and fluoboric acid for the fluoborate bath.

The curves shown in Fig 1 clearly demonstrate the stability of the fluoborate nickel bath in respect to changes of *p*H as compared to other commercial nickel baths.

Effects of Solution Variables

The data in Table II show the effect of three *bath concentrations*, as well as some comparative data for Watts-type and all-chloride nickel baths. The resistivity of the fluoborate bath decreases with increas-

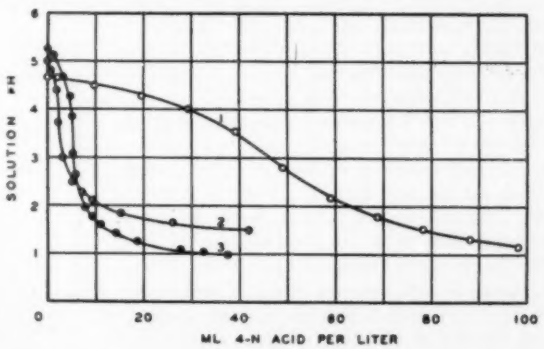


Fig. 1. Buffer curves for nickel plating solutions containing 75 g/l (10 oz/gal) nickel and 30 g/l (4 oz/gal) boric acid. (1) Fluoborate, (2) Watts-type, (3) all-chloride solution

TABLE II. EFFECT OF METAL CONCENTRATION
Bath temperature: 130° F

Nickel g/l	Boric Acid g/l	pH	Resistivity ohm-cm	Cathode LCD* asf	Current Efficiency, %		
					Anode		Cathode
					50 asf	100 asf	100 asf
Fluoborate Baths							
55	19	2.0	6.1	375	98.8	96.8	95
55	19	3.5	6.4	350	100	98.6	98
75	26	2.0	5.5	525	100.5	98	99
75	26	3.5	5.6	500	101	99	99
110	38	2.0	4.7	800	.....	100	98
110	38	2.5	4.8	750	.....	98	99
Watts-type Baths							
75	30	2.0	10.2	500	.....	....	....
110†	30	2.0	9.5	850	.....	....	....
All-chloride Bath							
75	30	2.0	5.6	500	.....	....	....

*LCD = limiting current density at 1-mil thickness.
†Approximate solubility limit at 130° F.

ing metal concentration. At equal metal concentrations the resistivity of the fluoborate bath is approximately 50 per cent of that of the sulfate-chloride bath and equals the low resistivity of the all-chloride bath.

Comparisons of limiting cathode current density with the other baths indicate that at equal metal concentrations the limiting current densities are comparable. However, the high solubility of nickel fluoborate makes possible the formulation of baths with extremely high metal contents and correspondingly high limiting current densities. This factor also minimizes salting out of the metal on equipment and anode bags.

The anode and cathode efficiencies of the fluoborate nickel baths are high. The cathode efficiencies are approximately 95–98 per cent over the range of *p*H values used. The cathode efficiency falls off rapidly when the *p*H is decreased below values of 1.5.

Studies of deposits produced from fluoborate solutions on Hull-cell panels show them to be uniform in color and texture, actually exhibiting some sheen over a wide range of current densities. The deposits are distinctly different from the dull mat gray deposits from the conventional Watts-type solution.

As shown in Table III, increasing amounts of *boric acid* do not have any effect on the appearance of the deposits, but the resistivity of the bath is increased slightly and the limiting current density is lowered somewhat. Because of this it is desirable to operate the plating bath with low concentration of free boric acid. In order to eliminate the possibility of free fluoride ion in the bath, a small excess of boric acid over the amount required to combine with the fluoride is used in the plating solution. Because of the excellent buffer characteristics of the fluoborate bath itself, boric acid is not required for additional buffering action so necessary in the sulfate-chloride baths.

Chloride in the form of nickel chloride hexa-hydrate was added to the bath to determine its effect on anode performance. As shown in Table IV, the chloride ion had a pronounced effect at the cathode, in that increasing amounts of the ion led to an increasing tendency of the deposits to pit. As the chloride ion increased, the pitting became progressively worse and the deposits were very dark and highly stressed, as evidenced by pronounced curving of the steel Hull-cell panel during the plating. While pitting can be controlled, it is advantageous to operate the bath without chloride additions. It was found that nickel anodes now used commercially can be used in the bath over a wide range of operating conditions without the necessity for adding chloride. This allows the

TABLE III. EFFECTS OF BORIC ACID*
Nickel content: 110 g/l
Bath temperature: 130° F

pH	Boric acid g/l	Resistivity ohm-cm	Cathode LCD†
2.0	10	4.7	800
2.0	25	...	750
2.0	40	5.0	700
3.6	10	4.8	750
3.6	25	...	725
3.6	40	5.4	700

*All deposits had good color and were somewhat lustrous.
†LCD = limiting current density at 1-mil thickness.

TABLE IV. EFFECTS OF CHLORIDE ION CONCENTRATION
Total nickel content: 110 g/l
Bath temperature: 130° F

$NiCl_2 \cdot 6H_2O$ g/l	Boric Acid g/l	*p*H	Resistivity ohm-cm	Hull-cell deposit*	
0	38	2.0	4.7	Somewhat lustrous, good color	Slight irregular pitting
0	38	3.5	4.8	" "	"
1	38	2.0	...	" "	"
1	38	3.5	...	" "	"
2	38	2.0	...	" "	"
2	38	3.5	...	" "	"
4	38	2.0	...	" "	"
4	38	3.5	...	" "	more pitting
7.5	38	2.0	...	" "	"
7.5	38	3.5	...	" "	"
15	38	2.0	...	" "	much pitting
15	38	3.5	...	" "	"
30	38	2.0	...	Dark at low current density	Very much pitting
30	38	3.5	...	"	"
44	27	2.0	4.8	Slightly dark	Bad pitting
88	27	2.0	4.8	" "	"
176	27	2.0	4.9	Dark	"
352	27	2.0	4.3	Very Dark	Highly stressed
396	27	2.0	4.2	" "	" "

*Obtained without the use of anti-pitting agent.

use of a one-component fluoborate system, thus simplifying control and maintenance of the solution. Since chloride ions in nickel baths materially increase the internal stress of the deposits, as shown below, deposits of relatively low internal stress can be produced by omitting the chloride ion.

Throwing Power

Throwing power tests were made on an inclined cathode plated at an average current density of 60 asf. All tests were run for two hours at 130° F. Throwing power was determined by the following formula:

$$TP = \frac{DR - MDR}{DR} 100$$

where DR = distance ratio: distance from far point of cathode to anode/distance from near point of cathode to anode
MDR = metal distribution ratio: metal on near point/metal on far point

The results are compiled in Table V. They show

TABLE V. RESULTS OF THROWING POWER TEST
Bath temperature: 130°

Bath No.	Nickel g/l	NH_4BF_4 g/l	$NaBF_4$ g/l	*p*H	Throwing Power %	DR	Specific Resisitivity ohm-cm
1	75	...	...	3.5	−75	1.583	5.2
	75	...	...	4.5	−155	1.583	...
2	75	100	...	2.7	−18	1.583	3.7
	75	100	...	3.5	−20	1.475	3.8
3	75	50	...	2.0	−88	1.583	3.9
4	75	...	200	3.5	−65	1.583	4.2
	75	...	200	3.5	−29	1.475	4.1
Watts	75	...	...	4.2	−88	1.5	10.5
	65	...	...	2.7	−75	1.4	11.0

that the throwing power in the nickel fluoborate bath and in the Watts-type bath are approximately equal. Haring-cell tests gave the same results. The addition of ammonium fluoborate to the nickel fluoborate solution decreased the resistivity and improved the throwing power as measured under the conditions of the test. The addition of 100 g/l of ammonium fluoborate to a solution containing 75 g/l nickel as fluoborate resulted in a solution operating close to the saturation point. Since the advantage of 100 g/l ammonium fluoborate over 50 g/l ammonium fluoborate was slight, the lower concentration is preferred where throwing power and low resistivity are important factors such as in barrel plating.

Physical Properties of the Deposit

Sheets of inconel, about 6 by 8 inches, were plated with nickel from the fluoborate solutions to a thickness of about 20 mils (500 μ). The nickel deposits were removed for testing from the unpickled inconel. Standard tensile specimens were cut from the resulting nickel sheets along the horizontal axis. All tests were in quadruplicate.

The physical properties of deposits from the fluoborate nickel solutions are summarized in Table VI. The solutions with lower concentration of metal produce the harder, stronger deposits. The stress-reducing agents saccharin and para-toluene sulfonamide (see below) increase the strength and hardness of the deposits with corresponding loss of ductility. The results were quite erratic because of the brittle nature of the deposit and the difficulty experienced in preparing good tensile-test specimens.

The present authors believe that the brittleness of the deposit observed in the tensile test is caused by successive failure of the individual laminae as they slip along the striations in the deposits. These striations can be seen in photomicrographs of deposits from baths containing the organic addition agents. Examination of tensile-tested foil shows a stepwise break across the thickness of the specimen at approximately 45° angle, which indicates that the deposit did not resist the applied force as an integral body but rather as a series of metal layers. Bend tests, however, indicate that the deposits are quite ductile.

Photomicrographs of deposits produced from the plain fluoborate bath show a structure similar to that produced from the all-chloride nickel bath. This, coupled with the low internal stress of the fluoborate deposits, would indicate that the fluoborate system is well adapted to electroforming applications, especially where dimensional stability is a factor.

Stress in the Deposits

The effect of plating variables on the stress in nickel deposits is summarized in Table VII.

It is lower in deposits from fluoborate solutions than in those from Watts-type baths. The effect of chloride in nickel fluoborate solutions is to increase the stress in the deposited nickel. The effect of hydrogen peroxide, which may be added to control pitting, is also very interesting. In the Watts-type bath, additions of hydrogen peroxide increased the stress far beyond its original value, whereas in the fluoborate bath the effect was slight. The stress in the deposits

(*Continued on page 1263*)

TABLE VI. PHYSICAL PROPERTIES OF NICKEL DEPOSITS FROM FLUOBORATE SOLUTIONS

Nickel g/l	*p*H	Temp. °F	Current Density asf	Addition	Yield Point psi	Ultimate Strength psi	Elong. in 2 inches %	Vickers Hardness
110	2.0	130	75	None	40,300	54,800	20.4	164
75	2.5	130	75	None	52,700	74,500	16.6	183
75	2.5	130	75	Wetting agent	52,900	70,300	19.2	175
75	3.5	130	75	None	44,600	69,800	13.0	159
75	3.5	130	75	0.2 g/l saccharin	.....	81,600	....	470
75	3.5	130	75	0.4 g/l saccharin	.....	85,000	....	470
75	3.5	130	75	0.6 g/l saccharin	.....	79,700	....	545
75	2.5	130	75	1.0 g/l saccharin	120,200	203,000	1.0	466
75	3.5	110	50	0.25 g/l p-toluene sulfonamide	.....	28,100	....	545
75	3.5	110	50	0.05 g/l p-toluene sulfonamide	.....	122,100	....	600
55	2.5	130	75	None	58,300	81,400	14.4	204
55	2.5	90	50	None	83,(00	99,600	10.4	270
55	3.5	90	50	None	84,000	100,500	13.5	243
55	4.0	90	50	None	79,300	106,600	7.6	280
55	3.5	90	25	None	66,200	120,800	5.5	305
55	3.5	90	25	0.2 g/l saccharin	.....	20,625	....	600
55	3.5	90	25	0.6 g/l saccharin	.....	20,350	.. ..	601

POLISHING and BUFFING

a literature review

James H. Lindsey
Dearborn, Michigan

Buffing

References*: 2, 7, 24, 47, 60.

Buffing may be defined as the smoothing of a metal surface by means of flexible wheels coated with lubricated fine abrasive. The operation may be subdivided into "cutting-down," in which metal on the order of 0.0001 inch is removed, and "coloring," which is a light buffing for the purpose of producing a high luster.

Preliminary to a detailed discussion of compounds and buffs, an understanding of their functions on the metal is desirable. These are at least four in number:

1. The removal of material by the cutting action of the abrasive, a factor of great importance in buffing such metals as steel but of less importance in the buffing of such soft metals as copper or zinc or such tough materials as stainless steel.
2. Burnishing, by which such soft metals as zinc are flowed plastically into a smooth surface under the high heat and pressure existing under the buff.
3. Incorporation of minute amounts of foreign material into the buffed surface.
4. Chemical reaction at the high heat and pressure whereby metallic soaps are formed by the reaction of fatty acids in the compound with the metal being buffed. This results in the removal of some stock and has a definite effect on color.

Buffing Compounds

References: 2, 7, 10, 12, 21, 22, 26, 27, 33, 39, 47, 52, 54, 55, 59, 60.

The compounds may be in bar or liquid form. They consist of an abrasive either compounded with a binder or suitably emulsified or suspended in a fluid carrier.

Bar Compounds.—The functions of the *abrasive* is to cut the metal, which it performs much in the manner of a tool in a shaper or planer. It must not injure the material being buffed and must be capable of being readily removed subsequent to buffing.

In general, buffing compounds with relatively high abrasive content (known as "dry" compounds) are used for light work, compounds high in grease content for heavier buffing requiring more lubrication to prevent overheating. Between the two lies a multitude of grades, so that the problem becomes one of selection, with actual tryout the best means of establishing a choice.

A wide variety of abrasives is available for buffing:

Tripoli is a natural amorphous silica obtained from the Seneca, Mo., field. It is very widely used for cutting-down, and for many coloring operations. It possesses the advantage of breaking to present new cutting edges as the original facets dull. It contains some iron, however, and this may be a definite disadvantage, as in the coloring of stainless steel, which will become stained by rusting of the iron.

Amorphous silica is identical with tripoli both chemically and physically but is free from iron. It is finer and softer, hence better suited to coloring than tripoli.

Ground quartz flour is definitely objectionable because its edges do not break to present new cutting faces. It is used only because its low oil absorption permits a saving to the compound manufacturer.

Vienna lime consists of unslaked magnesium and calcium oxides, ground and sealed against the air while hot. Although widely used as a nickel-coloring abrasive, it is open to the very serious objection that the lime may be slaked at any time by moisture picked up upon exposure to air. Moreover, if it reacts with the stearic acid in the binder, manufacture, buffing, or cleaning may be rendered impossible; even small quantities left on the work may cause serious difficulty during subsequent plating operations.

Diatomite is a material similar to tripoli but softer. It consists of the skeletons of marine plants called diatoms and is 96 per cent silica.

Aluminum oxide buffing powders (not to be confused

* See first installment in November issue.

with the aluminum oxide abrasives produced by electrical fusion and used for polishing and grinding) are prepared by oxidizing, but not fusing, ground bauxite ore which has been purified to remove silicon and iron. These abrasives are important in the coloring of stainless steel and chromium plate. It may be noted that the Carborundum Company at one time campaigned for the substitution of these powders for tripoli and other abrasives containing free silica on the basis of reduced health hazard.

Green chromic oxide is widely recommended for high coloring of stainless steel and chromium plate.

Whiting is used for the final hand coloring of stainless-steel surgical instruments.

Rouge used in buffing is commonly red but may be any of several colors, depending upon the degree of oxidation; all rouges being pure iron oxides, chemically prepared. Rouge is the only satisfactory abrasive for the buffing of gold and silver but is very dirty to use. Mention is made of a water-soluble rouge having been developed. This abrasive cannot be used for the coloring of stainless steel because of discoloration.

Crocus is a grade of finely ground iron oxide ore, coarser than rouge. It has now been largely displaced by tripoli and other abrasives.

Turkish emery, or corundum, in fine grades has been used for initial buffing of stainless steel but cannot be used for coloring because of its iron content.

The functions of the *binder* are complex. It must (1) lubricate the work to prevent overheating, yet must not mask the cutting action of the abrasive; (2) hold the abrasive to the wheel until its cutting edges are dulled, then remove itself; (3) prevent adhesion to the work; (4) regulate the plastic flow of the metal; (5) protect the buff; and (6) permit subsequent removal of buffing dirt by available cleaning processes. It is evident that the formulation of a buffing-compound binder calls for a high degree of skill and experience. The following materials are most commonly used:

Tallow of a selected hard grade (either beef or mutton), free from moisture and impurities, is saponifiable and readily emulsifiable. It is used to temper the hardness of a compound, greatly increase the cutting action, and give good color.

Double-pressed distilled stearic acid is manufactured from tallow. It is employed for its high hardness and toughness and because it is readily saponified and has the ability to emulsify other greases. Forming metallic compounds, it hastens the buffing action. Alone, or combined with tallow, stearic acid gives the best color and luster of any of the binder materials.

Hydrogenated fish oils are harder than tallow and completely saponifiable, but they do not color quite as well as tallow.

Hydrogenated-fish-oil fatty acids are used to replace stearic acid because of their lower cost. Unlike stearic acid they do not crystallize, and they lack its toughness and high coloring ability. These acids are almost completely saponifiable.

Petroleum jellies are used in a wide range of consistency and degree of purity. They are readily emulsifiable and are therefore easily removed by alkaline cleaning if combined with sufficient saponifiable grease to form stable emulsions. They are used to promote adhesion of the compound to the buff, and give better pull and cut than other lubricants.

Stearine pitch is hard and brittle and largely unsaponifiable. It is used to reduce cost but is objectionable because it will contaminate cleaning solutions.

Natural waxes, such as Japan wax, beeswax, Candellilla wax, and Carnauba wax are excellent binders. Japan wax is harder than animal tallow, is more readily emulsified, and is completely saponifiable. Beeswax has high melting point and toughness, but is only about 50 per cent saponifiable. Carnauba wax is extremely hard and has a high melting point.

Scale wax lubricates more than tallow and is sometimes used to replace part of the saponifiable greases in order to cheapen the compound. It decreases the cut and smokes badly when heavily loaded in buffing.

Paraffin wax, which is refined scale wax, shares the disadvantages of the latter to a degree. It is much harder, however, and has a higher melting point. Both of these waxes present cleaning difficulties.

Paraffin oil is used to soften a compound cheaply. It smokes badly, however, and is hard to remove in an alkaline cleaner.

Sodium salts of sulphonated alcohols have been used in compounds to promote their removal by cleaning.

Liquid Compounds (references: 24, 28, 30, 47, 60).—The foregoing comments regarding abrasives apply equally to abrasives used in liquid buffing compounds. The binders, however, are generally oil emulsions. The functions of such vehicles are similar to those of the binders in the bar compounds so far as the action of the compound on the wheel is concerned, but in addition the oil emulsion must hold the abrasive in suspension without excessive or permanent settling and must permit handling of the compound by means of a pressure-pot spray-gun system. There is no published material on the makeup of these compounds.

The use of liquid buffing compounds is an outgrowth of the development of greaseless compounds, and its present status was made possible by the development of suitable spraying equipment. Although for commercial reasons the principal effort has been directed to the development of tripoli compounds, liquid spraying compounds have also been developed for the buffing of stainless steel, nickel, and other materials.

Savings, which are said to be appreciable, result from (1) reduction in compound-handling time; (2) faster cutting due to greater exposure of the abrasive grains; (3) reduced waste of compound due to use of an even coating of compound and to the avoidance of "nubbins ; and (4) increased buff life due to better protection by the compound.

Liquid compounds are adaptable to automatic feed-

ing at predetermined intervals and may therefore be used on automatic buffing machines.

Testing of Compounds (reference: 25).—The testing of buffing compounds merits special attention. The following should be considered in conducting such tests:

1. Recording output per hour, per man, and per day.
2. Conducting the test over a day or, if possible, a week.
3. Starting the test with new buffs, and weighing them to determine loss during the test.
4. Weighing the composition used and any remaining at the end of the test to determine the actual consumption.
5. Recording number of rejects.
6. Checking facility of subsequent cleaning.
7. Evaluating appearance of the finished parts.
8. Particularly important in compounds to be used in automatic or semiautomatic machines are such factors as the strength and texture of the cakes to avoid breakage; melting point; and cleanliness.
9. Balancing the findings in respect to these matters against the cost of the material per pound.

Buffing Wheels

References: 2, 4, 12, 14, 33, 39, 47, 51, 52, 54, 55, 60.

In purchasing wheels for polishing or buffing, the important dimensions are the arbor-hole diameter, the outside diameter, and the width of face. If the arbor-hole is too large for the spindle, the wheel will not run true; if too small, enlargement by the customer will usually have the same effect.

Wheel diameters should be specified so as to result in peripheral speeds as close as possible to the correct speeds for the work to be buffed. The use of worn or small wheels on high-speed lathes to maintain surface speed should be regarded with caution because the resultant loss of effective contact area may render the practice uneconomical.

It is economical to specify the widest wheel that the shape or size of the product and facility of handling will permit (up to the point of overloading the lathe). A narrow-faced wheel wears rapidly and requires more labor because of the small working area and because of the unnecessary laps which must be removed by added labor. For the buffing of local areas, of course, the wheel width should correspond to the width of the area to be buffed.

Materials.—Most buffs are made from cotton-muslin sheeting, which is specified in the trade by the number of warp (lengthwise) and filling (crosswise) threads and, in addition, by the number of yards of length for a stated width per pound of material. In general, a soft, loosely woven sheeting is used for heavy buffing, and the thread count for all types of buffing will lie between 48/48 and 84/92.

Not covered by the thread-count designation are such factors as the staple, or length, of the cotton fibers in the yarn, the degree of twist in spinning the yarn, the diameter of the yarn, and the method of weaving, all of which have a bearing on the quality of the sheeting. Because a relatively small portion of the cotton-sheeting output is used for buffs, such factors are beyond the direct control of the buff manufacturers. The best that can be done, therefore, is to deal with suppliers whose products have been found satisfactory, whether one is purchasing the sheeting or the buffs themselves.

Bleached goods is usually harder and firmer than similar unbleached cloth, due to the shrinkage of the yarn, the sizing and the finishing treatments after bleaching, and is therefore preferred for heavy-buffing (or "cutting-down") operations rather than for coloring. The use of starch or other filler is not desirable because such materials tend to interfere with absorption of the buffing compound.

Canton flannel, a twill-weave cotton fabric with a long soft nap on one side, is often used for the coloring of such metals as aluminum. Sheepskin buffs, alone or in conjunction with cloth buffs, are sometimes used for the coloring of electrodeposits and plastics. Because these buffs form only a very small portion of the total usage, the discussion of the various buff types which follows is confined to those made from cotton-muslin sheeting.

Buff Types.—A standard full-disc loose buff section consists of twenty discs of sheeting (though this will vary with the application) assembled two at a time on a rotating table so as to vary the direction of the weave and thereby insure uniform face wear. The discs are held together by a single row of sewing around the arbor hole. Each section is $\frac{3}{8}$–$\frac{5}{8}$ inch thick. As a result of its construction, this buff gives a wheel which is flexible and conforms well to the contours of a piece. If constructed of hard, closely woven sheeting, it may be used for heavy buffing of soft metals; in the softer, loosely woven grades it is an ideal coloring medium.

All types of sewing increase the hardness and decrease the flexibility of a buff section in a degree proportional to the closeness of the rows of stitching and to the number of stitches per inch. Unfortunately, the influence of these factors and of the pattern of the sewing cannot be (or at least has not been) stated in numerical terms of buff hardness. Choice, therefore, is generally based on personal opinion to a considerable extent.

Spacers of cardboard, worn sections, or metal spacers may be inserted between sections or discs to obtain a softer wheel and to provide a cooling, or ventilating, effect.

Spiral sewing is the most widely used sewing and is the cheapest because it can be done on semiautomatic sewing machines. On economic grounds, therefore, it should be first choice, unless previous experience indicates its use unsatisfactory for a particular operation. The degree of hardness can be influenced within limits by the spacing of the rows and of the individual stitches. The off-center nature of the stitching, how-

ever, does result in uneven hardness of the face of the wheel which may result in waves or chatter marks.

Because of the symmetry of the sewing, buffs with concentric circular sewing avoid the waves or chatter marks which may be encountered with spiral-sewed buffs. The degree of hardness may be varied widely. For example, practically all of the flexibility of an unsewed buff can be preserved when a few rows of sewing near the arbor hole are added to increase the hardness to a degree. The cost is higher than for spiral sewing, particularly in the case of special or uneven spacings.

Sun-ray sewed buffs provide fast cutting because of the pockets formed by the rows of stitching radiating from the center. Hardness, and speed of cut, may be increased by increasing the number of sewings.

Square-sewed buffs are recommended for the heaviest buffing operations because this type of sewing produces the maximum hardness obtainable, yet preserves a high degree of resiliency. Although slightly higher in cost than concentrically sewed buffs, the added expense is frequently justified by the results obtained. The buff owes its performance both to the hard spots at the ends of the rows of stitching and to the pockets between the rows which retain the buffing compound.

Buffs in which the cloth layers have been folded or puckered to produce pockets have been developed as a result of the growing use of automatic equipment. Such construction results in fast cutting with very little loss of flexibility. Flexing of the pockets in use provides cooling, enabling the buffs to withstand the high speeds and pressures used in automatic buffing. Frequently the cloth in these buffs is cut or woven on the bias to minimize wear due to fraying.

In the vast majority of cases, the expense of special sewings is not warranted, and their use is to be avoided if at all possible.

Sewed piece buffs consist of scraps of cloth laid in layers as uniformly as possible and sewn between two full discs. Originally the scraps came from trimmings resulting from the cutting of full discs, but the demand for these buffs has led to the use of mill ends and other scrap materials. These materials are usually bleached, resulting in a relatively hard wheel, but in as much as the solid sewing necessary to retain the small scraps of material makes this type of buff inherently hard in any case, this is actually advantageous. Although the handling of so many small pieces is relatively expensive, it is more than offset by lower material costs, resulting in lower net cost than for comparable full-disc buffs. As has been inferred, these buffs are suited for relatively heavy buffing.

The user of piece buffs, because of their construction, is dependent upon the manufacturer for quality. It is therefore recommended that such buffs be purchased only from known and reputable manufacturers.

Mounting of Buffs (reference: 51).—When the buff sections are assembled on the lathe spindle, washers may or may not be used between sections depending upon the degree of hardness or flexibility desired. When used, they should be omitted between the two outer sections on each side of the wheel. The assembled buffs are then pushed against the back-up washer, which is integral with the spindle, the thrust washer and retaining nut are assembled on the end of the spindle, and the nut is tightened in a direction opposite to that of spindle rotation. The nut is tightened almost, but not quite snug by means of a wrench while the spindle is held by means of the hand brake. Up to this point the spindle has not been rotated, but it is now spun momentarily to permit the buff sections to align themselves by the action of centrifugal force. The nut is then drawn up tight.

The buffing wheel will not run true in this condition and must therefore be raked lightly by means of a board studded with (No. 2 common) nails to remove inequalities. During the operation, the rake should be supported on some such surface as the edge of the wheel housing. An equally important function of raking is the raising of a soft nap on the wheel to provide a cushioning effect and to help absorb the buffing compound.

Buffing Speeds

References: 1, 12, 14, 20, 22, 26, 27, 31, 39, 47, 52, 56, 59, 60.

In no phase of buffing practice is there greater disagreement than in the specification of peripheral speed. This is an item of some importance, because the maximum speed consistent with satisfactory results and with economical compound usage is the cheapest from the standpoint of labor.

The nature of the parts being buffed, type of compound, pressure, type of buff, and buff ventilation will vary from plant to plant, and indeed from job to job, and such factors may be responsible for the disagreement noted. In automatic buffing operations, the higher pressures used will require lower buff speeds to avoid overheating than could be used in comparable hand operations. This may also be a factor.

Perhaps the best approach to this problem is that used by one writer who judges the speed by the amount of tripoli ejected from the buff. The buff is run at several speeds, and at each the compound is caught by a cardboard in the blower and weighed. If the speed is too low, the tripoli will not adhere properly to the buff; if too high, it will be liquefied and thrown off excessively. Coupled with observation of the quality of the work and of the output rate, this should be a satisfactory procedure for the establishment of proper speed for a given operation.

Published buffing speeds are given in Table III.

Equipment

References: 11, 26, 27, 35, 37, 44, 53, 55, 57.

Whether automatic buffing and polishing are applicable to a given job is largely a matter of whether the projected production quantity is sufficient to justify the equipment costs. The only additional limits are the ingenuity of the equipment designer and the practice of the finishing personnel. The efficiency of automatic

TABLE III. PUBLISHED BUFFING SPEEDS

Material	Buffing Speed—surface feet per minute
Not specified	9,700[5]; 9,000–10,000[12]; around 10,000[14]
Aluminum	
cut down	6,500–7,500[20]; 7,000–7,500[39]; 8,500–10,000[47]; 6,000–8,000[56, 60]
color	7,000–8,000[20]; 7,500–8,000[39]; 6,500–8,000[47]; 6,000–7,000[56, 60]
Carbon steel	
cut down	10,000–12,000[47]; 9,000[56, 60]
color	10,000–12,000[47]; 7,000–9,000[60]
Chromium plate	
color	7,000–8,000[56, 60]
Copper alloys, including brass	
cut down	9,500[26, 27]; 8,500–10,000[47]; 7,000–9,000[56]; 6,000–9,000[60]
color	9,500[26, 27]; 6,500–8,000[47]; 6,000–8,000[56, 60]
Nickel and nickel-silver	
cut down	9,000–10,000[47]; 7,000–9,000[56]; 6,000–9,000[60]
color	7,000–8,000[47]; 6,000–8,000[56, 60]
Stainless steel and monel	
cut down	9,000–10,000[22, 56]; 12,000[26, 27]; 10,000–12,000[47]; 10,000 min[52]; 10,000 max[59]; 10,000[60]
color	9,000–10,000[22]; 12,000[26, 27]; 10,000–12,000[47]; 9,000 max[52]; 8,000–9,000[56]; 10,000 max[59]; 7,000–9,000[60]
Zinc	
cut down	8,500–10,000[47]; 6,000–8,000[56, 60]
color	6,500–8,000[47]; 6,000–7,000[56, 60]
Thermosetting plastics	
cut down	4,000–6,000[31]
color	4,000–5,000[31]
Thermoplastics	
cut down	3,000–4,000[31]
color	3,000–4,000[31]

polishing and buffing is dependent upon the use of the correct combination of wheels, wheel speeds, work-rotating or -linear speeds, length of dwell of wheel in contact with work, and kind and feed of compound.

The first requisite is a means of holding and supporting the work at the high pressures generally employed. The work fixtures may be arranged to rotate at indexing stations on a horizontal or vertical table; to travel linearly under a succession of wheels or belts, cammed, if necessary, to present different surfaces to the wheel; or to pass the work under successive reciprocating wheels or abrasive belts. Specific applications are illustrated in cited literature.

Automatic feeding of compound should preferably be arranged for preset intermittent operation irrespective of whether bar or spray compound is used.

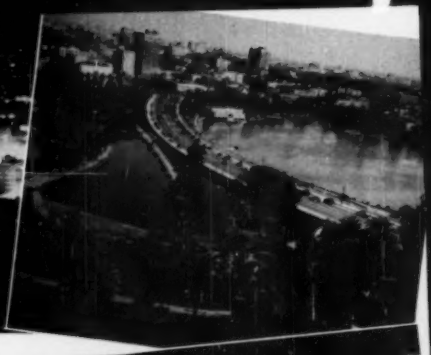
Hand-polishing lathes have undergone considerable refinement during the period covered by this review. Among the available features are multiple heads, increased clearance for bulky work, and adjustable speeds.

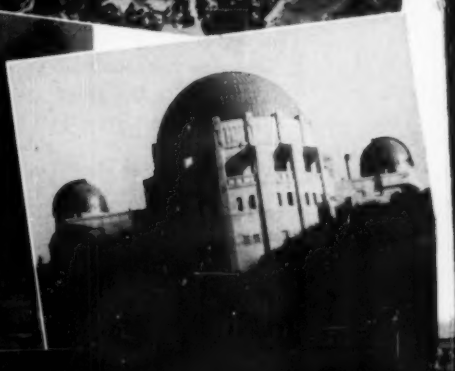
Dust collection has also received substantial attention from the equipment manufacturers. Individual and central systems are available.

Correction And Note

Dr. H. L. Kellner of the Lea Manufacturing Company, Waterbury, Conn., and Mr. A. J. Emmerich of J. J. Siefen Company, Detroit, Mich., have brought to our attention an error on pp. 1145 and 1148 of the first part of this article, which appeared in the November issue. Greaseless compounds contain abrasives in a glue-base binder, not a sodium silicate-binder.

Following the period covered by this review, several publications have appeared which are pertinent to the general subject: General Motors' "Set-up Instructions for Polishing and Buffing Wheels" were republished in the October and November, 1949, issues of PLATING. Belt polishing was treated in the March and April, 1950, issues of PLATING and in two papers in the 1950 *Proceedings* of the American Electroplaters' Society. The latter also contains a paper about liquid-suspended buffing compounds. The article in the April, 1950, issue of PLATING describes, in addition, brush-backed polishing with abrasive-coated strips.





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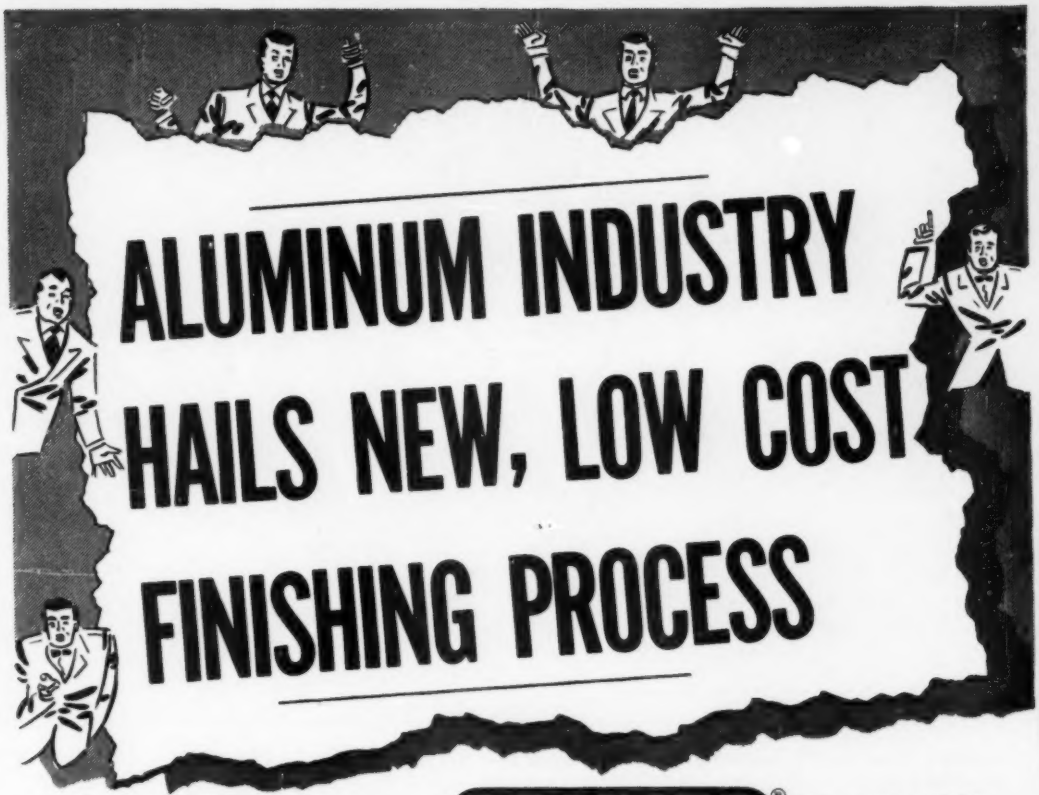

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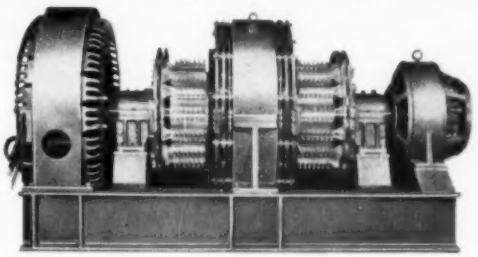

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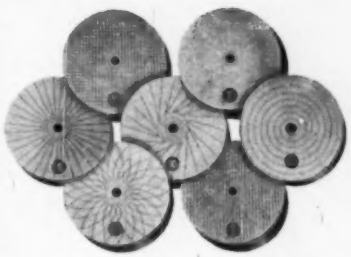

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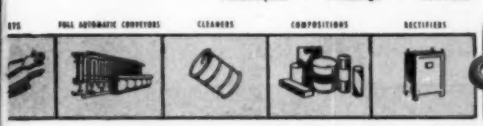

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Grain Size and Hardness of Nickel Plate as Related to Brightness

HAROLD J. READ* AND ROLF WEIL†

Introduction

It was shown in an earlier paper[1] that there is no relationship between preferred orientation and the brightness of nickel deposits. The search for correlations between brightness and structural or physical properties of the deposit has been continued in an investigation of the grain size and hardness of a group of specimens prepared from solutions containing a variety of brightening agents. These two properties have often been mentioned in the literature as being connected with brightness, but there is no report on the comparison of many specimens prepared under identical conditions, except for the brightener.

Although X-ray methods can be used for the determination of grain size in metals, there are factors which make the results uncertain in many cases. There is a "blind spot" between 5×10^{-4}mm and 2×10^{-4}mm where X-ray patterns are insensitive to grain size[2]. This happens to be the critical region for bright and semi-bright nickel deposits, and it is therefore necessary to use optical methods.

Experimental Procedure

The panels used by Smith, Keeler and Read[1] in their X-ray investigation were also employed for the present study. The plating conditions as well as the brighteners and their concentrations are given in Table I. The technique of solution purification and some details concerning the basis metal are given in the earlier paper[1].

Two pieces about 0.5 × 0.5 inch (1.3 × 1.3 cm) were cut from the middle of each panel after having been suitably marked to preserve their orientation in the panel. They were plated heavily with dull nickel to protect the edges during metallographic preparation and mounted in Bakelite in such a manner that one piece represented a vertical and the other a horizontal cross-section of the deposit with respect to the position which the panel occupied in the plating bath. No appreciable difference in the appearance of the two pieces was ever found. The specimens were polished by the usual methods, ending with optical rouge suspended in a solution of tincture of green soap and water. The most effective etchant was found to be a solution of equal volumes of 5 per cent NaCN and 5 per cent $(NH_4)_2S_2O_8$ (by weight) aqueous solutions. The etchant‡ should be freshly mixed, and the stock solutions should not be kept for more than a day or so. The structure of the steel basis metal, which is not attacked by the above-mentioned etchant, can be revealed by etching with 2 per cent nital (2 ml conc HNO_3 in 98 ml C_2H_5OH) without affecting the nickel which has already been etched. All specimens were examined and photographed with a research-type metallograph equipped with every facility for the maximum possible resolution with an optical microscope.

The unpolished surfaces of some of the panels were examined in the electron microscope. The great depth of focus of this instrument permits the photographing of surface irregularities which would be hopelessly blurred in the optical microscope. The surface structures were brought out by an electrolytic etch for 15 sec in 5 per cent H_2SO_4 (by weight) in water at 0.1 amp/dm² (0.9 asf), followed by the application of a drop of concentrated HNO_3, which was immediately washed off, on the area to be examined. Replicas were made with collodion in amyl acetate and were shadowed with chromium.

The hardness measurements were made with a Knoop indentor and a 25 g load in a Tukon Microhardness Tester on the same specimens as were used in the metallographic part of the work. The hardness numbers were calculated from the average of three or four readings on each specimen, and the individual readings were reproducible within a range the limits of which for the poorest agreement were defined by values representing a deviation of ±6 per cent of the average value. In many cases ±2 per cent deviation encompassed the range of readings.

Results and Discussion

Grain size

The geometry of the grain structure of the deposits did not lend itself to the making of measurements whereby a single linear dimension could be employed to designate the grain size. Recourse was had, therefore to a visual classification of the photomicrographs into

*Associate Professor of Metallurgy, The Pennsylvania State College, State College, Pennsylvania.
†Graduate Assistant, Division of Metallurgy, The Pennsylvania State College, State College, Pennsylvania.
‡We are indebted to Mr. E. J. Roehl for suggesting this etchant.

TABLE I. PLATING CONDITIONS AND BRIGHTENERS

Bath composition: 42 oz/gal single nickel salts, $NiSO_4.6H_2O$; 6 oz/gal nickel chloride, $NiCl_2.6H_2O$; 5 oz/gal boric acid, H_3BO_3
Plating conditions: pH 4.0; temperature, 140° F; current density, 50 asf; thickness of deposit, 0.0025 inch
Panel preparation: electropolished bumper stock

Panel	Addition Agent
NAX	None
A-2	0.2 g/l saccharin
A-4	0.4 g/l saccharin
A-6	0.6 g/l saccharin
B-2	0.2 g/l 1–5, naphthalene disulfonic acid
B-4	0.4 g/l 1–5, naphthalene disulfonic acid
B-6	0.6 g/l 1–5, naphthalene disulfonic acid
B-8	0.8 g/l 1–5, naphthalene disulfonic acid
B-10	1.0 g/l 1–5, naphthalene disulfonic acid
C-2	0.2 g/l p-toluene sulfonamide
C-4	0.4 g/l p-toluene sulfonamide
C-6	0.6 g/l p-toluene sulfonamide
C-8	0.8 g/l p-toluene sulfonamide
C-10	1.0 g/l p-toluene sulfonamide
D-2	0.2 g/l m-benzene disulfonic acid
D-4	0.4 g/l m-benzene disulfonic acid
D-6	0.6 g/l m-benzene disulfonic acid
E-2	0.2 g/l 2–7, naphthalene disulfonic acid
E-4	0.4 g/l 2–7, naphthalene disulfonic acid
E-6	0.6 g/l 2–7, naphthalene disulfonic acid
E-10	1.0 g/l 2–7, naphthalene disulfonic acid
F-1	1.0 g/l Zn plus 0.6 g/l 1–5, naphthalene disulfonic acid
F-2	1.0 g/l Zn plus 1.0 g/l 1–5, naphthalene disulfonic acid
H-1	0.2 g/l chloral hydrate plus 0.6 g/l 1–5, naphthalene disulfonic acid
H-2	0.2 g/l chloral hydrate plus 1.0 g/l 1–5, naphthalene disulfonic acid
H-3	0.6 g/l chloral hydrate plus 1.0 g/l 1–5, naphthalene disulfonic acid
K-1	2.5 g/l formaldehyde plus 0.6 g/l 1–5, naphthalene disulfonic acid
K-2	2.5 g/l formaldehyde plus 1.0 g/l 1–5, naphthalene disulfonic acid
L-1	15.0 g/l Ni-formate plus 0.6 g/l p-toluene sulfonamide
L-2	30.0 g/l Ni-formate plus 0.6 g/l p-toluene sulfonamide
N-1	0.2 g/l chloral hydrate plus 0.6 g/l p-toluene sulfonamide
N-2	0.6 g/l chloral hydrate plus 0.6 g/l p-toluene sulfonamide
O	2.5 g/l formaldehyde plus 0.6 g/l p-toluene sulfonamide

several groups wherein each member of a group was *distinctly* different from the members of other groups. In a way this follows the well-established practice of the American Society for Testing Materials wherein grain size is evaluated by comparison of specimens with standard charts. It was found that five groups were sufficient to encompass all of the specimens studied in this investigation, and that there was no difficulty in deciding into which group a particular specimen should be classified. A resume of the classification of all specimens is given in Table II, and photomicrographs of a typical specimen from each group are shown in Figs. 1–5. A small area of the steel basis metal is shown in each photomicrograph, and the thickness of nickel represented is approximately 0.0015 inch (38μ). Fig. 6 is an electron-microscope picture at 10,000× of the specimen shown in Fig. 5, and it will be seen that there is no information which is not visible in Fig. 5, although the details are somewhat clearer.

The comparison between grain size and brightness is

TABLE II. GRAIN-SIZE DISTRIBUTION

(Group I is coarsest—Group V is finest)

Group No.	Specimen Nos.
I	A2, A4, A6, B2, NAX, D2
II	B4 C8, C10
III	C6, D4, D6, K2, L1, L2, N1, N2
IV	B6, B8, B10, C2, C4, E10, H2, H3, K1, O
V	E2, E4, E6, F1, F2, H1

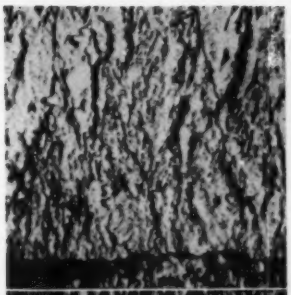

Fig. 1. Specimen A6. Typical of grain-size group I. 1000×

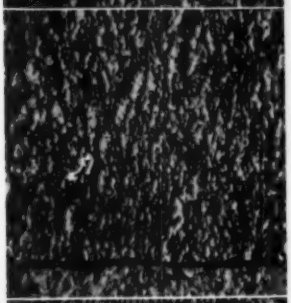

Fig. 2. Specimen C10. Typical of grain-size group II. 1000×

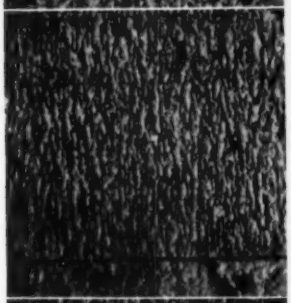

Fig. 3. Specimen N1. Typical of grain-size group III. 1000×

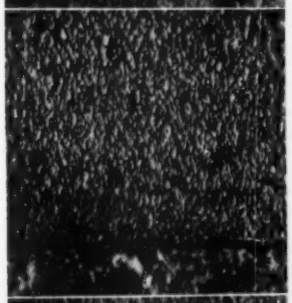

Fig. 4. Specimen C4. Typical of grain-size group IV. 1000×

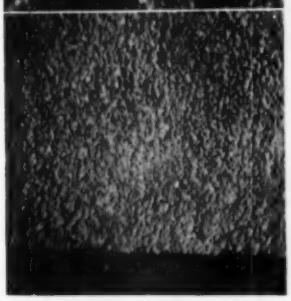

Fig. 5. Specimen H1. Typical of grain-size group V. 1000×

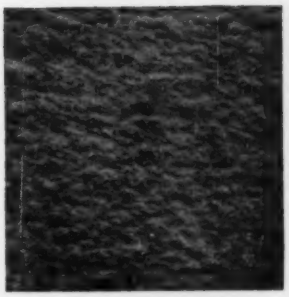

Fig. 6. Specimen H1. Electron micrograph. 10,000×

best presented graphically, and Fig. 7 serves this purpose. It is obvious that although there is a general trend indicating that the grain size decreases with increasing brightness, there is no well-defined relationship. The members of a given brightness class span from three to four grain-size groups, and a given grain-size group may span from two to four brightness classes. Note particularly that grain-size group III encompasses the entire range of brightness from the dull D4 to the brightest panels in the collection, N1 and N2. A smiliar plot was prepared for reflectometer evaluations of brightness, and although the position of some specimens was altered, the general aspect of the plot was the same as Fig. 7. A plot of preferred orientation against grain size was also prepared. It too had the same general appearance as Fig. 7, but there was a broad trend indicating that the amount of preferred orientation decreased as the grain size decreased.

The electron-microscope photographs shown in Figs.

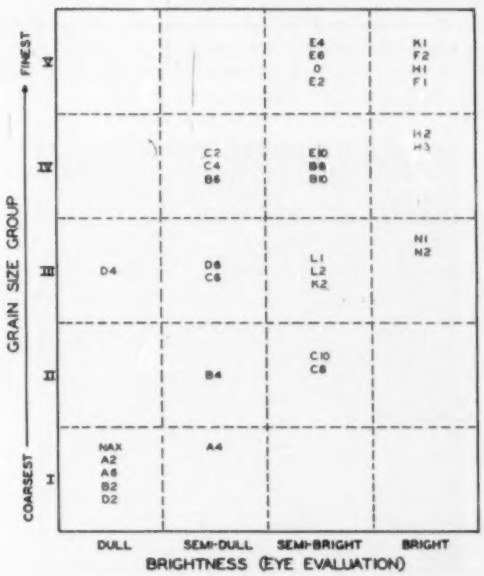

Fig. 7. Relationship between grain size and brightness of electrodeposited nickel

Fig. 8. Specimen D2, dull. Etched surface. 10,000×

Fig. 9. Specimen A4, semidull. Etched surface. 10,000×

8–11 are generally representative of the etched surface structure of the specimens in each of the four brightness classes, although the twin-like structure in Fig. 8 is not found in all dull deposits. The structure shown in this photograph can be discerned in unetched specimens, but it is not so clearly defined. All specimens falling in brightness classes other than dull had to be etched to reveal any structure.

An examination of Figs. 9–11 makes it appear that the surface structure bears only a general relationship to the brightness since, e.g., semi-bright L1 (Fig. 10) has at least as fine a structure as bright N1 (Fig. 11), and on the basis of shadow length and distribution L1 appears to be much flatter and smoother. It must be remembered, however, that these surfaces were etched, albeit very lightly, and no longer are the surfaces which were judged in the evaluation of brightness.

The expression "grain size" has been used herein with some misgivings because it is by no means certain that what is seen in the photographs represents grains in the usual metallurgical sense of the word. It might have been better to use the word "texture," but because the structures observed have been so often referred to in terms of grain size in the electroplating literature, the term has been used herein.

Laminated structures were observed in a few of the deposits, but they were the exception rather than the rule. Specimen N1 (Fig. 3), one of the brightest deposits in the series, shows only a few faint signs of the banding that sometimes appears in bright nickels.

Hardness

In Fig. 12 Knoop hardness numbers for all specimens are plotted against brightness. Again there is only a

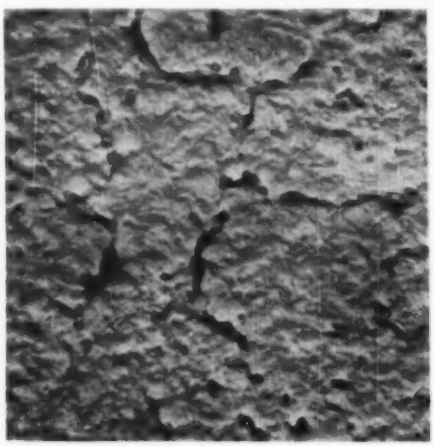

Fig. 10. Specimen L1, semibright. Etched surface. 10,000×

Fig. 11. Specimen N1, bright. Etched surface. 10,000×

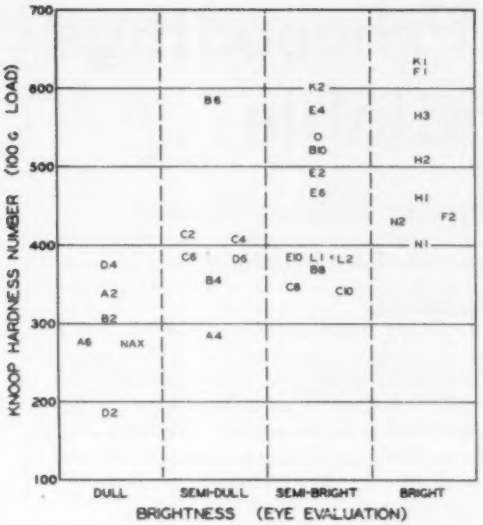

Fig. 12. Relationship between hardness and brightness of electrodeposited nickel

general correlation. It is interesting to note, however, that Figs. 7 and 12 are, to a certain extent, quite similar. Fig 13 was prepared to examine more closely this similarity, and it is evident that there is a fairly definite trend indicating that the hardness increases as the grain size decreases, although the scatter is considerable in the region of high hardness and small grain size. It is true that this is generally to be expected as

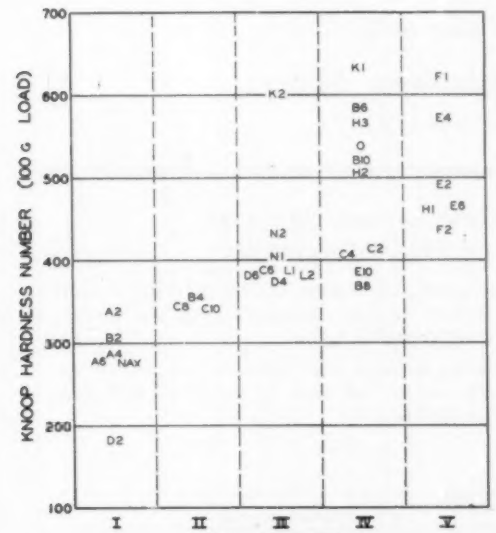

Fig. 13. Relationship between hardness and grain size in electrodeposited nickel

an ordinary metallurgical phenomenon, but for these nickel specimens where the variety of codeposition possibilities arising from the use of numerous brighteners might be expected to affect the hardness, it does appear somewhat surprising that there is such a good correlation between hardness and grain size. It might be well to emphasize that one dull depoisit, D4, was nearly as hard as the brightest plates, N1 and N2, and that amongst the bright deposits there was a range of hardness from 400 to 640. Since N1 and N2 were not very much harder than deposits from a plain Watts-nickel bath, it may not be a vain hope to expect that brighteners could be found which would lead to bright deposits that are even softer than Watts nickel. At least there is little justification for the frequently expressed opinion that bright plates are harder than those which are not so bright.

Hardness itself is of comparatively little interest as a property, but there has been a tendency to associate it with tensile strength and brittleness which are indeed vital properties. Although it is generally true that for massive metals the hardness increases as the tensile strength and brittleness increase, this is not the case for electrodeposited metals in the thicknesses used for protective and decorative purposes. It is evident, therefore, that in order to evaluate the effect of brighteners on tensile strength and ductility, it will be necessary to measure these properties directly. Unfortunately, it was not possible to do this with the specimens used in the present investigation, but it is hoped that a suitable study can be instituted in the future.

It may be of interest to record that hardness was plotted against the concentration of organic material in the solution. The resulting figure showed that in a general way the hardness increases as the concentration of organic addition agent is increased, but the correlation is as rough as the trends shown in Figs. 7 and 12.

Conclusion

There is no correlation between the brightness of nickel deposits and their grain size or hardness. Although there does exist a very broad general trend which indicates that the brightness increases with decreasing grain size and increasing hardness, the specific exceptions are so numerous that they become more significant than the general trend.

Acknowledgement

The specimens used in this investigation were furnished by Dr. A. K. Graham and Mr. H. L. Pinkerton of Graham, Crowley and Associates, Inc., Jenkintown, Pa. Mrs. Virginia Black was the technician in charge of the electron microscope used in this investigation.

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(Continued from page 1246)

from the chloride bath is high compared to deposits from the fluoborate bath. Since the resistivities of these two baths are about equal, the fluoborate bath offers great promise for electroforming applications where dimensional stability is important.

The ability of organic compounds such as saccharin and paratoluene sulfonamide to reduce stress is illustrated in this table. Both these materials may be used to reduce the internal stress to approximately zero.

Effects of Impurities

A study was made of the effects of additions of copper, zinc, lead and iron on deposits produced from fluoborate and Watts-type nickel solutions. Hull-cell deposits on buffed brass plates were examined visually and by bending. The tests indicated that fluoborate solutions had greater tolerance to these metallic impurities. The concentrations of the impurities studied were considerably lower than those studied by Roehl and Wesley[5]. Large amounts of the impurities will cause the same effects in the fluoborate bath as in Watts-type solutions. The metal-ion contaminants can be removed by low-current-density electrolysis.

Organic impurities have similar effects in nickel fluoborate plating solutions as in other nickel baths. They can be removed by treatment with activated carbon.

Bright Plating Possibilities

Commercial bright-nickel processes are based upon the Watts-type nickel bath. One process uses additions of cobalt, nickel formate and formaldehyde in combination. The other processes use one or more compounds chosen from the group of primary organic nickel brighteners, including aromatic sulfonates, sulfimides and sulfonamides, usually in combination with wetting agents and a secondary brightener. In a nickel fluoborate bath, formaldehyde exerts a profound brightening effect, whereas the effect of nickel formate is slight and small additions of cobalt apparently without effect. The primary organic brighteners all exert a profound brightening effect when used in the nickel fluoborate bath, without the deposits attaining the degree of brightness required by commercial bright nickels. Full brightness resulting from the further addition of brighteners of the second class has not been fully explored.

In addition to bright-nickel plating, processes for plating semibright and easily buffed nickel have been developed in recent years. The high conductivity and rapid-plating characteristics of the nickel fluoborate system offer interesting possibility for further development in this direction.

TABLE VII. EFFECT OF PLATING VARIABLES ON STRESS IN NICKEL DEPOSITS*

Nickel g/l	$NiCl_2$. $6H_2O$ g/l	$NiSO_4$. $7H_2O$ g/l	Boric Acid g/l	*p*H	Stress in 1000 psi				
					110° F			160° F	
					50 asf	100 asf	50 asf	100 asf	250 asf
55	0	0	20.6	3.0	....	24.3	....	....	....
55	0	0	30.0	3.0	....	24.0	....	....	....
71	0	0	30.0	2.0	....	24.2	....	....	....
71	0	0	30.0	3.0	16.1	22.4	16.7	24.5	16.7
71	0	0	30.0	4.0	....	23.9	....	....	....
71	0	0	30.0	4.5	....	26.3	....	....	....
73.5	10	0	30.0	3.0	....	28.5	....	....	....
78.5	30	0	30.0	3.5	26.0	33.8	23.3	28.5	20.2
75†	0	0	28.0	3.5	....	25.5	....	....	....
110	0	0	41.0	3.5	....	24.0	....	....	....
110▲	0	0	41.0	3.0	....	−1.6	....	....	....
71▲	0	0	30.0	3.0	−3.1	−2.0	−1.0	−0.4	−1.0
75●	0	0	28.2	3.5	−1.1	....	−1.8	....	....
75	30	315	30.0	3.7	24.8	....	23.2	27.4	28.9
75‡	30	315	30.0	3.5	95.5◆	....	....	....	....
75†	30	315	30.0	3.5	....	....	87.2◆	....	....
75	300	0	30.0	1.0	38.8◆	....	32.7◆	37.1◆	....
75	300	0	30.0	2.0	44.8◆	....	....	....	....

*Stress determined and calculated by method of Soderberg and Graham[6].
†Addition of H_2O_2 (O_2 = 12 ppm).
‡Addition of H_2O_2 (O_2 = 5 ppm).
▲Addition of saccharin, 1 g/l.
●Addition of para-toluene sulfonamide, 1 g/l.
◆Values not accurate, elastic limit of copper base metal having been exceeded in test.

APPENDIX

Preparation of Nickel Fluoborate Plating Baths:

Nickel fluoborate is available in the form of concentrate containing 44 per cent by weight of nickel fluoborate, $Ni(BF_4)_2$. A typical analysis follows:

	Wt—%	*g/l*	*oz/gal*
Nickel fluoborate, $Ni(BF_4)_2$	44	695	43.1
Nickel, Ni	11.1	176	23.6
Free Boric Acid, H_3BO_3	3	47	6.3

The specific gravity of the concentrate is 1.58, i.e., the solution weighs about 13.2 lb/gal.

The nickel fluoborate concentrate is diluted with water to the desired metal concentration. To prepare 100 gallons of plating solution the amounts given below are used:

	55 g/l Ni		*75 g/l Ni*		*110 g/l Ni*	
	lb	*gal*	*lb*	*gal*	*lb*	*gal*
Nickel fluoborate concentrate	410	31.1	557	42.2	819	62
Water	573	68.9	482	57.8	317	38

After the bath has been made to the desired concentration, it is heated to the operating temperature and the *p*H of the solution is adjusted. The *p*H of the solution is raised by adding nickel carbonate or lowered by adding fluoboric acid. The solution is then purified by electrolysis at a low current density while it is being agitated. After purification the bath is ready for use.

Control

While analytical methods are available for all bath constituents, it is possible to control the metal concentration of the solution successfully by means of hydrometer readings and the *p*H by means of colorimetric papers.

Suggested Applications

The properties of the solutions and the nickel deposits produced as described in this article should suggest the use of fluoborate solutions in many applications. Some which are being explored at present include: electroforming, barrel plating, electrotyping, plating of stereotypes.

Acknowledgment

The authors wish to acknowledge the assistance of Dr. A. K. Graham, Consultant, Graham, Crowley & Associates, Inc., Jenkintown, Pa., in the planning and direction of this investigation.

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Book Review

DR. HAROLD J. READ

Associate Professor of Metallurgy, Pennsylvania State College

Journal of the Electrodepositors' Technical Society, Vol. 24, 1948-1949, 232 pages. The Electrodepositors' Technical Society, 27 Islington High Street, London, N. 1, England. Price to non-members, two guineas.

The current volume of papers read before our sister society in England encompasses an extremely wide range of important topics. Inasmuch as only two of the fifteen papers are on the same subject, it is difficult to list the subject matter of all the papers, much less examine each one critically, in the space available here. All of the articles are of considerable interest, some with respect to new developments, others with respect to reviews of current practice in the English metal-finishing industry.

Two papers on the evaluation of polished surfaces are interesting, although they do not present a solution to this vexatious problem. Gardam and Mills have very capably summarized the physical and psychological considerations which must be taken into account in any approach to surface evaluation.

A paper on the welding, brazing, and soldering of coated metals treats of a subject which has received comparatively little attention in the literature but will become of ever greater significance as the use of preplated strip for fabrication purposes increases.

The practical aspects of phosphate-coating methods and techniques have been well summarized in a paper by Holden. The discussion of this paper is particularly interesting and is replete with technical anecdotes of phosphating problems and their solutions.

Bradshaw and Clarke discuss the formation of anodized coatings on aluminum alloys with special reference to weight of coating, attack on the metal, density and micro-porosity of and stress in the coating.

Two papers on the use of barrels are only superficially similar, inasmuch as one deals with deburring and polishing and the other with barrel plating. Both papers are rather unusual in that they are more fundamental in their approach to the subject than is usually the case. The discussion relating to them is particularly interesting and indicates that there is much divergence of opinion in England on the technical value and the economics of barrel operations.

The emphasis in the entire volume is on current practices and indicates a very active trend towards the modernization of metal-finishing practices in England. The discussions of the papers reveal an extremely lively interest in any development which will lead to improved practices.

The discussions do not always follow the papers, and it would be helpful if the editors would append a cross-reference at the end of each article for which the discussion is to be found elsewhere in the book.

project no. 12

project director:
HENRY B. LINFORD*

associates:
EDWARD B. SAUBESTRE*

location:
COLUMBIA UNIVERSITY,
NEW YORK CITY

Acknowledgment us due the Research Committee, Mr. William M. Tucker, Eastman Kodak Company, Chairman; the Research Directing Committee, Mr. B. C. Case, Hanson-Van Winkle-Munning Company, and Mr. G. M. Cole, Ternstedt Division, General Motors Corporation, Chairman and Vice-Chairman, respectively; and the Project Committee, Dr. Herbert Bandes, Sylvania Electric Products, Inc., Chairman; Dr. Donald Price, Oakite Products, Inc.; and Dr. Edward Parker, Technic, Inc., for their contributions to this project.

*AUTHORS

DECEMBER, 1950

Cleaning and Preparation of Metals for Electroplating

1. CRITICAL REVIEW OF THE LITERATURE

Project No. 12 has for its purpose to develop a dependable test for determining when a metal surface, which is subsequently to be plated, is clean. This is not easy to accomplish. Already many tests which have suggested themselves have been discarded as impracticable or likely to be unreliable. However, it is felt that the objective is so important to electroplaters generally that no effort should be spared to develop such a test.

We wish to emphasize that it is not the purpose of this project to recommend cleaner formulations or to evaluate one type of cleaner against another. Rather, it is hoped to obtain basic information which will make it easier for everyone connected with the electroplating industry to decide when a particular metal surface is clean.—PROJECT COMMITTEE.

SUMMARY

The initial purpose of the project is to establish standards of cleanliness for metallic surfaces being prepared for electroplating. Upon establishment of such standards, convenient methods for determining the degree of cleanliness of the metallic surface will be investigated.

The importance of cleaning metals prior to electroplating is stressed, and the soils which commonly contaminate metal surfaces are discussed.

The methods currently utilized for the preparation of surfaces for plating are examined, and the principles of detergency are presented.

The various methods currently employed for evaluating the cleanliness of solid surfaces are outlined.

OBJECT

The object of this study is to investigate the cleanliness requirements of metals being prepared for electroplating. It is hoped that it will be possible to set up "standards of cleanliness", in which the surface characteristics of the metal will be correlated with the quality of electrodeposits plated thereon, e.g., their adhesion, porosity, and corrosion resistance. Finally, currently used evaluation tests will be analyzed and interpreted on the basis of these standards. Concurrently, refinements of these tests, as well

as new tests, will be investigated if results indicate the need.

1. INTRODUCTION

The Need for Metal Cleaning

Metallic surfaces must possess a satisfactory degree of cleanliness prior to various finishing operations in order that the finish be successfully applied. Such processes include electroplating, coating with rust preventives, vitreous enameling, japanning, painting, and lacquering, etc. Considerations of cleanliness also apply to such various shop operations as spot welding and annealing. The degree of cleanliness required and the method of cleaning will vary with the applications cited. Thus, with lacquering processes[10], a chemically clean surface, free of both alkali and acid, is required. In addition, the high lustre of the metal must not be affected. In cleaning before painting and japanning[10], it is usually not necessary to obtain such a chemically clean surface. The problem here is to remove heavy coatings of oil, grease, and dirt so as to leave a surface that is compatible with an oil primer or paint and at the same time to prevent rust formation on the object prior to painting or japanning. Vitreous enameling[10] requires meticulously cleaned surfaces for success. Metals to be spot welded must be substantially chemically clean; all dirts and oxides must be removed to permit an even flow of electric current[46].

The following sections will consider only the pretreatment of metals prior to electroplating. For adherent plates, the basis metal must in general be free of such organic soils as oils and fats, and such inorganic residues as oxide, tarnish, scale, pickle smut, and metallic particles.

The choice of cleaning processes prior to plating depends upon the type of soils present, the chemical nature of the basis metal and of the electrodeposited metal, the nature of the plating bath, the prior metallurgical treatment of the surface of the basis metal, and the purposes for which the electroplates are deposited.

2. TYPES OF SOIL

A. Organic Soils
   1. Mineral oils
   2. Animal and vegetable oils
   3. Cleaning and pickling residues

B. Inorganic Soils
   1. Rust and tarnish
   2. Dirt
   3. Scale and smut
   4. Cleaning residues

The soils commonly found on metallic surfaces may be divided as follows[10]:

A. Organic Soils

1. *Mineral oils*

These oils are insoluble in water, acid and alkali solutions. They are unsaponifiable. Water emulsions of such oils are generally not stable. The oils are soluble in many organic liquids, such as benzene and chlorinated hydricarbons.

2. *Animal and vegetable oils*

These materials are saponifiable, though the reaction is usually slow and incomplete. These oils are insoluble in water and soluble in such organic solvents as benzene and chlorinated hydrocarbons.

The aforesaid classes of soils arise from the use of buffing compounds, cutting oils, slushing compounds, protective oils, die and mold lubricants, etc.[4]. Very resistant films can form by thermal decomposition of coolant oils[108].

Organic compounds representative of these types are[71,130,147]: straight paraffin base mineral oils, sulfurized mineral oils, fatty oils, and sulfurized fatty oils (5–15 per cent S). The presence of free fatty acid facilitates the removal of fatty oils from pickled steels[167], but high free-fatty-acid content (10 per cent) reduces the ease of removal from unpickled steels[167]. At nearly equal viscosity, the ease of removal of oils from metallic surfaces is[167]: mineral oil > sulfurized mineral oil > lard oil > sulfurized lard oil.

3. *Cleaning and pickling residues*

Other organic contaminants may be present on the surface as a result of the cleaning and pickling operations. Thus, metal soaps may be formed *in situ* during the cleaning operation, and inhibitors used in acid pickling baths may be adsorbed on the metal surface.

B. Inorganic Soils

1. *Rust and tarnish*

This category is composed of oxides and salts of the basis metal which result from chemical action at the metal surface. They are usually insoluble in water and alkaline solutions but react readily with acid and cyanide solutions to form water soluble compounds. These soils arise from heat treatments of the metal surface and corrosion reactions.

2. *Dirt*

Dirt constitutes water-insoluble material. It often adheres to the oil present on the surface and can be removed simultaneously with it.

3. *Scale and smut*

Prior hent treatment of the metal may result in formation of scale on the surface. Pickling of high-carbon steel results in the formation of bloom, or smut, composed largely of carbon plus phosphides and oxides thrown out on the surface of the steel in pickling. Engine parts may become coated with carbon residues after long periods of use. All such materials are usually very troublesome to remove.

4. *Cleaning residues*

Various cleaning operations may also leave behind films of oxides, phosphates, silicates, passive layers, etc. Gases may be adsorbed on metallic surfaces, such as hydrogen in the cathodic cleaning of steel. Abrasive cleaning and polishing methods, such as buffing and polishing, also leave behind such residues as fine abrasive particles adhering to the metallic surfaces.

3. METHODS OF METAL CLEANING

A. Alkaline Cleaners
   1. Nonelectrolytic cleaners
      a. Bath composition
      b. Mode of operation
   2. Electrolytic cleaners
      a. Bath composition
      b. Mode of operation
   3. Characteristics of bath constiturnts
      a. Caustic soda
      b. Soda ash
      c. Phosphates
      d. Silicates
      e. Borax
      f. Soaps and synthetic detergents
   4. Principles of Detergency
      a. *p*H and titration values
      b. Surface action
      c. Saponification
      d. Water hardness
      e. Rinsability
      f. Corrosion
      g. Electrolytic effects

B. Solvent Cleaners

C. Solvent Emulsion Cleaners

D. Alkaline Copper Cyanide Cleaners

E. Descalers
   1. Abrasion cleaners
   2. Acid pickling baths
   3. Cyanide descalers
   4. Fused salt descalers
   5. Reducing atmospheres

The many methods currently employed for cleaning metal surfaces will now be discussed. The mode of action of each type of cleaner and representative formulas will be given.

A rough grouping of cleaners may be made as follows:

Degreasers (which remove oils, fats and oil-imbedded dirt) such as alkaline (nonelectrolytic and electrolytic), solvent, solvent-emulsion, and alkaline copper cyanide baths.

Descalers (which remove scale, oxide, and the like) such as acid pickling baths abrasion cleaners, fused salt baths, cyanide baths, reducing gas atmospheres, etc.

Actually, the division is not an absolute one, as degreasers will often remove some inorganic contaminants, and pickling and abrasive methods will remove greases to some extent. In practice, degreasing is usually the first step and is followed by descaling.

A. Alkaline Cleaners

Alkaline cleaning is the oldest and most prevalent method[46] of degreasing. In cur-

rent practice, alkalies are used as soak, spray, or electrolytic cleaners.

1. *Nonelectrolytic cleaners*

a. *Bath composition.*—The number of different alkaline cleaning solutions reported in the literature is very large. There would be little point in enumerating these baths here or in listing the hundreds of references to be found in the literature. Table I gives some representative solutions suitable for spray or soak cleaning.

b. *Mode of operation.*—In soak cleaning, the soiled work is simply immersed in the cleaning solution for as long a period of time as is found to be required. The bath is usually kept at the boiling point, or nearly so. Agitation is not provided where boiling produces sufficient stirring of the solution. The tanks are usually constructed of steel. The cleaner concentration is 2–12 oz/gal. Various means are provided for avoiding recontamination of the work when it is being removed from the bath. Thus, the top of the bath may be skimmed off periodically, an overflow tank may be used, baffles may be provided, etc.

In spray cleaning, the work must be so shaped that direct impingement of the spray can occur over the entire surface of the article to be cleaned. Surface-active agents must be chosen that do not form stable foams. The concentration of the cleaner is 1/8–1 oz/gal. Drag-out of cleaner solution is usually quite high.

Alkaline cleaning is followed by a water rinse. This rinse must be very thorough, especially where soap is present, or else the subsequent acid pickle will release fats on the surface.

2. *Electrolytic cleaners*

a. *Bath compositions.*—Simply stated, electrolytic cleaning consists of alkaline cleaning with the aid of electric current. The bath compositions are about the same as in nonelectrolytic alkaline baths. The formulations shown in Table II are typical of solutions used for electrolytic cleaning.

b. *Mode of operation.*—In general, the soiled work is immersed in the cleaning tank for as long a time as is necessary, this time being much less than for soak cleaning. Though baths are heated, the temperatures used are somewhat lower than those of soak cleaners. Agitation is provided by the gases evolved at the electrodes.

In the early days of electrocleaning, little attention was paid to whether the work should be made the anode or the cathode. Cathodic cleaning was the rule. Today, both cathodic and anodic ("reverse-current") cleaning are employed, depending on circumstances.

Other factors remaining the same, twice as much gas is evolved in cathodic cleaning as in anodic cleaning, thus providing for more mechanical action. There

TABLE I. REPRESENTATIVE NONELECTROLYTIC ALKALINE CLEANING SOLUTIONS

The formulations herein are taken from information given the Project Committee for A. E. S. Research Project No. 12 by various industrial firms. The starred formulations are the ones which will be used in Project No. 12 but are not recommended for general use in the industry. These formulations are related to average cleaners of their class, and their use does not imply superiority over any other formulations listed or available.

All figures are per cent by weight.

Brass

Formulation Number	1*	2	3	4	5	6	7	8	9
$Na_3PO_4.12H_2O$	50	..	..	30	35	32	35	..	..
$Na_4P_2O_7$	..	10	..	20	..	..	5	..	..
$Na_6P_4O_{13}$	..	..	..	..	15	..	..	..	..
$Na_2SiO_3.5H_2O$	30	60	52	30	30	..	50	41	..
$3Na_2O.2SiO_2.11H_2O$	..	..	..	..	..	..	..	..	100
$Na_2Si_2O_5$	..	..	..	..	..	..	..	54	..
Na_2CO_3	13	20	46	15	13	47	..	..	..
NaOH	..	..	..	..	..	16	8	..	..
Wetting agent	7	10	2	5	7	5	2	5	..
Concentration, oz/gal	4–12					2–8	4–8		2–8
Temperature, ° C	80–95								

Steel†

Formulation No.	1*	2*	3	4	5	6	7	8	9	10
$Na_3PO_4.12H_2O$	32	..	..	32	32	55	35	50	..	9
$Na_4P_2O_7$	..	..	4	20	..	..	5	..	..	..
$Na_6P_4O_{13}$	..	..	..	..	15	..	..	..	..	..
$Na_2SiO_3.5H_2O$	..	..	40	..	..	..	50	30	..	29
Na_2SiO_4	..	85	..	..	..	..	..	..	..	..
Na_2CO_3	46	10	..	26	31	35	..	13	60	18
NaOH	16	..	50	16	16	10	8	..	30	36
Wetting agent	6	5	6	6	6	..	2	7	10	8
Concentration, oz/gal	4–12	4–12				4–8	4–8	2–8	2–8	
Temperature, ° C	boil	boil								

Aluminum

Formulation Number	1	2
$Na_3PO_4.12H_2O$	33	50
$Na_2SiO_3.5H_2O$	66	30
Na_2CO_3	..	13
Wetting agent	1	7
Concentration, oz/gal	6	2–6
Temperature, ° C	80–95	

†In addition, the following are used as single-agent cleaners at concentrations of 2–8 oz/gal: Na_2CO_3, $Na_3PO_4.12H_2O$, $Na_4P_2O_7$, $Na_2SiO_3.5H_2O$, Na_2SiO_4, $3Na_2O.2SiO_2.11H_2O$.

TABLE II. REPRESENTATIVE ELECTROLYTIC ALKALINE CLEANING SOLUTIONS

The formulations herein are taken from information given the Project Committee for A. E. S. Research Project No. 12 by various industrial firms. The starred formulations are the ones which will be used in Project No. 12 but are not recommended for general use in the industry. These formulations are related to average cleaners of their class, and their use does not imply superiority over any other formulations listed or available.

All figures are per cent by weight.

Brass: Cathodic

Formulation Number	1*	2	3	4	5	6
$Na_3PO_4 \cdot 12H_2O$	50	..	..	20	50	..
$Na_4P_2O_7$	..	10	15	..	..	..
$Na_2SiO_3 \cdot 5H_2O$	20	60	50	50	30	..
Na_2SiO_4	..	..	..	..	..	90
Na_2CO_3	20	20	12	20	20	..
NaOH	10	..	20	10	..	..
Wetting Agent	..	10	3	..	..	10
Concentration, oz/gal	4–8			6	2–6	4–6
Temperature, ° C	80					80
Current Density, asf.	20–35					

Brass: Anodic

Formulation Number	1*	2	3	4
$Na_3PO_4 \cdot 12H_2O$	25	..	35	25
$Na_4P_2O_7$	..	15	5	..
$Na_2SiO_3 \cdot 5H_2O$	..	50	50	..
Na_2SiO_4	..	..	..	20
Na_2CO_3	55	12	..	55
NaOH	20	20	8	..
Wetting agent	..	3	2	..
Concentration, oz/gal	4–6		4–8	
Temperature, ° C	80			
Current Density, asf	25–40			
Time, sec	5			

Steel: Anodic†

Formulation Number	1*	2	3	4	5	6
$Na_3PO_4 \cdot 12H_2O$	35	..	..	55	25	10
$Na_4P_2O_7$	5	9	..	..	..	5
$Na_2SiO_3 \cdot 5H_2O$	50	35	..	..	..	12
Na_2SiO_4	..	..	50	..	..	..
Na_2CO_3	..	..	20	35	55	..
NaOH	8	55	28	10	20	70
Wetting agent	2	1	2	..	..	3
Concentration, oz/gal	6–12	6–12	6–18	2–6	2–6	
Temperature, ° C	80–100		95–105			
Current Density, asf.	50–100		60–100			

†In addition, the following are used as single-agent cleaners at concentrations of 3–10 oz/gal: $Na_3PO_4 \cdot 12H_2O$, $Na_4P_2O_7$, $Na_2SiO_3 \cdot 5H_2O$, $3Na_2O \cdot 2SiO_2 \cdot 11H_2O$.

are, however, several serious drawbacks to cathodic cleaning. Because sodium hydroxide is present in the immediate vicinity of the cathode, amphoteric metals such as zinc, lead, and tin are attacked and dissolve to form Na_2ZnO_2, Na_2PbO_2, Na_2SnO_3, etc. There is also corrosive action on copper and on iron and their alloys. This results in the cleaning solution becoming contaminated with metal ions at low concentration which deposit in a loosely adhering layer. This causes poor plating[113-116]. Hydrogen at the cathode tends to diffuse into steel, causing hydrogen embrittlement, an especially difficult problem in the case of highly stressed high-carbon steels.

The use of anodic cleaning will prevent embrittlement and the appearance of loose skins of metal on the surface. On the other hand, in addition to the fact that anodic metals may go into solution, the oxygen present will attack the surface of many metals, causing tarnishing, staining, etc. Because of this, anodic cleaning is not successful with many metals. In case of parts that usually receive a cathodic treatment, a brief anodic treatment may be used to remove loose metallic skins[105]. Anodic cleaning is also useful where soap is present in the bath. Hard water may cause the deposition of a light, but adherent, film of calcium and magnesium soaps, especially at high *p*H. Anodic cleaning at 80–100 asf (8.6–11.7 amp/dm²) will remove this film[127]. Sometimes, articles covered with soils removable only with difficulty are given a brief preliminary anodic treatment to cause partial oxidation of the soil so as to render it easier to remove in the subsequent electrocleaning operation[123].

One cycle reported in the literature, which also plates the steel object with a thin copper coating, operates as follows[81]:

Electrode connection	*Cur. Density asf*	*Time min.*	*Purpose*
Anode	150–200	1	Remove grease
Cathode	150–200	7	Remove rust
Anode	15–20		Remove spongy Cu
Cathode	25		Deposit Cu

3. *Characteristics of bath constituents*

The following comments on the compounds used in alkaline cleaning baths have been summarized from these general references[1,32,102,103,112,123,126,169].

a. Caustic soda.—This compound is very useful where saponification of fatty oils is desired. Otherwise, caustic soda is a poor detergent, being a poor wetting and emulsifying agent. The caustic content is entirely active, and there is little buffering; as a corollary, only small quantities need be added to raise the *p*H of alkaline cleaners to desired levels. Where soap is present, caustic soda tends to break down emulsions in some cases. Caustic has poor rinsability. It attacks aluminum

and zinc, stains brass, etc. In electrolytic baths, caustic soda is generally present to insure good conductivity of the solution.

b. *Soda ash.*—Although sodium carbonate has good buffer action, this action usually occurs at a *p*H too low to be of value in the usual metal-cleaning baths. Carbonates and bicarbonates are poor detergents, having poor wetting and emulsifying ability. The carbonates, especially sodium sesquicarbonate ($Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$), assist the development of soap-produced oil emulsions. The carbonates do not have good rinsability. When hydrated alkaline salts and caustic are left standing in the dry state, the mixture becomes soapy owing to water absorption by the caustic. The presence of soda ash tends to prevent this.

c. *Phosphates.*—The ortho-phosphates are fairly good buffers and fair wetting and emulsifying agents. The action of soap is aided by the presence of ortho-phosphates. These compounds have excellent rinsability. The most commonly used ortho-phosphate is $Na_3PO_4 \cdot 12H_2O$, but $Na_2HPO_4 \cdot 12H_2O$ is used occasionally. The pyrophosphates and complex phosphates are used because of their ability to prevent formation of hard-water scale on the work being cleaned. Their compositions are given in the section on water hardness. Pyrophosphates are good detergents in their own right.

d. *Silicates.*—The silicates are excellent buffers and, of the alkalis, are the best wetting, emulsifying, and deflocculating agents. Sodium ortho-silicate is the best of the silicates in terms of detergent action. The silicates have fair rinsability, being better in this respect than soda ash at high temperature and worse at room temperature. The less siliceous silicates have the better rinsability among the silicates. In the presence of hard water, silicates deposit semicolloidal calcium and magnesium silicates, which on standing give rise to a nonadhering sludge. The silicates, especially those of high SiO_2/Na_2O ratio, are good corrosion inhibitors for aluminum and other such metals. The commonly used silicates are listed in Table III.

Meta-, sesqui-, and ortho-silicates usually exist in true solution, but the siliceous silicates nearly always exist in colloidal solutions.

Hydrolysis of the meta compound proceeds as follows:

$$\begin{array}{ccccc} Na_2SiO_3 & = & 2\,Na^+ & + & SiO_3^{-2} \\ & & + & & + \\ 2H_2O & = & 2OH^- & + & 2H^+ \\ & & \| & & \| \\ & & 2NaOH & & H_2SiO_3 \\ & & & = & H_2O + SiO_2 \end{array}$$

The silicic acid formed is present as a variably hydrated silica molecule. It does not react readily with NaOH and tends to precipitate as colloidal silica. Alternatively it may form complex charged micelles with the silicate ions, such as:

$$SiO_3^{-2} \cdot ySiO_3 \cdot x\,H_2O$$

The latter will occur in the presence of such other alkalis as caustic soda, soda ash, and phosphates. Hydrated silica, while not reactive with NaOH, does react with metals, as can be seen by the formation of siliceous deposits on iron parts in silicate cleaning baths. Acids tend to precipitate silica.

e. *Borax.*—Borates are too mild and find little place in metal cleaning compositions. Borax (sodium tetraborate) itself has poor detergent properties.

f. *Soaps and synthetic detergents.*—Such compounds are added to most alkaline cleaners to decrease surface tension and interfacial tension against oil. They emulsify oil and suspend solid particles of dirt in the solution (deflocculation, or peptisation in European terminology). The addition of alkali to soap solutions increases their surface tension but greatly decreases their interfacial tension against oil[122-124].

For centuries, the most important detergents have been the soaps, i.e., the alkali salts of higher fatty acids. In recent years, synthetic detergents have risen in prominence. The earliest synthetics were sulfated fatty alcohols, derived from vegetable-oil raw materials. Later came the sulfonated alkylated aromatics and sulfonated straight-chain hydrocarbons, both based on petroleum raw materials.

In electrolytic baths, soap is usually avoided as it stabilizes foams on the surface of the bath. These foams entrap large quantities of oxygen and hydrogen, leading to explosions, especially at high current densities[112]. Fortunately, the explosion is directed inward, as three volumes of reactants yield two volumes of product.

TABLE III. COMPOSITION OF SILICATES

Name	Formula	Na_2O/SiO_2
Sodium ortho-silicate	Na_4SiO_4 (commercial product has $0\text{–}5H_2O$)	2:1
Sodium sesqui-silicate	$Na_6Si_2O_7 \cdot 11H_2O$, *or* $2(Na_3HSiO_4 \cdot 5H_2O)$	3:2
Sodium meta-silicate	Na_2SiO_3 (stable hydrates are 4, 6, and 9 H_2O; the commercial product approximates $5H_2O$)	1:1
Silicate of soda, or water glass	Commercial grades available in Na_2O/SiO_2 ratios indicated	1:1.6 1:2 1:3.3–3.2

TABLE IV. *p*H OF 1 PER CENT AQUEOUS SOLUTIONS OF ALKALINE COMPOUNDS[22]

Compound	Name	*p*H
NaOH	Caustic soda	13.4
$3Na_2O \cdot 2SiO_2 \cdot 11H_2O$	Sodium sesqui-silicate	12.7
$Na_2SiO_3 \cdot 5H_2O$	Sodium meta-silicate	12.5
$Na_3PO_4 \cdot 12H_2O$	Trisodium phosphate	12.0
$Na_2O \cdot 1.6SiO_2$	Silicate of soda	12.0
Na_2CO_3	Soda ash	11.4
$Na_2O \cdot 2SiO_2$	Silicate of soda	11.3
$Na_2B_2O_4 \cdot 4H_2O$	Sodium meta-borate	10.8
$Na_2O \cdot 3.2SiO_2$	Silicate of soda	10.2
$Na_4P_2O_7$	Tetra sodium pyrophosphate	10.1
$Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$	Sodium sesqui-carbonate (trona)	9.9
$Na_2B_4O_7 \cdot 10H_2O$	Borax	9.2
$NaHCO_3$	Sodium bicarbonate	8.4
$Na_6P_4O_{12}$	Sodium tetraphosphate	8.4

4. *Principles of detergency*

The following general references deal with the theoretical aspects of alkaline cleaning[7,9,11,25,32,33,34,40,57,71,90,93,102,103,108,120,123,125,152,170,179,184,89]:

a. *pH and titration value.*—In the earlier days of preparing alkaline cleaning-bath formulations, it was frequently thought that a very high *p*H promoted good detergency. Hence, caustic soda solutions were frequently utilized, either alone or with small amounts of phosphates and other alkaline compounds. As time has passed, it has become evident that caustic is actually a fairly poor detergent, unless the cleaning action is solely one of saponification, which is almost never the case. On the other hand, detergency is poor or nonexistent at *p*H less than 8–8.5, and this figure may be regarded as the lower limit for alkaline metal cleaners[32]. Platers' cleaners generally have a *p*H in the range from 11.0 to 11.5.

(To Be Continued)

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readers' questions of general interest

Q. 104. What methods are available for coloring of stainless steel?

A. Chromium-nickel and chromium stainless steels may be blackened in a molten bath of sodium bichromate operating at 750–775° F (U. S. Patent No. 2,394,899). A smooth black oxide film about 0.00001 inch thick is produced in 15–30 minutes. It is normally dull black in color and may be improved in luster by the application of oils or waxes. The blackening shows no tendency to turn gray in service. It meets the requirements of U. S. Army Spec. No. 57-O-2C for Type III finishes.—A gold color may be imparted to stainless steels by immersion in a molten sodium nitrate bath operating at 730°–840° F (U. S. Patent No. 2,431,986). The color will vary from a light straw to a reddish gold depending upon the grade of stainless steel, the time of immersion, the surface finish, and the bath temperature. This process has been used to identify different sizes of similar parts and different grades of stainless steel.—K. M. Huston.

A. An electrolytic method in which stainless steel is made the anode in a sulfuric acid-sodium dichromate solution is described in an article by Naylor in the February, 1950 issue of Plating. A range of colors from brown through blue, yellow, reddish purple and deep purple to green are obtained on 18-8 stainless steel. Black films may be obtained on stainless steels containing less nickel.—K. G. Soderberg.

Q. 105. What salt-spray life may be expected on refrigerator racks which have been zinc plated and given a clear chromate film?

A. The generally accepted salt-spray life of clear chromate films to white corrosion varies between 72 and 100 hours. Seventy-two hours cover the chromate film itself, and 100 hours where a clear bake lacquer is used. These values can be obtained providing there is close control of the entire operation. Some variation, both up and down, has been found in production, but 72 hours can be set down as an average. A zinc thickness of 0.0002 inch is considered satisfactory; however, an increase in protection against white corrosion of the chromated part is noted when zinc thickness is increased to 0.0007 inch. Above this figure, the thickness of zinc appears to have little effect on the time for white-salt formation. The protection finally obtained with a chromate film, particularly of the thin, clear type, is very much dependent upon such variabl as base metal, cleaning, pickling, and plating. The type of bleach dip used for removing the chromate color and the subsequent rinsing procedure are also of importance.—C. W. Ostrander.

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Caustic Soda versus Construction Materials. Chem. Eng. **56,** 213–214, 216, 218, 220 (December, 1949).

Part I of a symposium in which a representative group of construction materials are evaluated for services involving caustic soda. Includes the following: "Chlorimet," Walter A. Luce; "Worthite," W. E. Pratt; "Lead," Kempton H. Roll; and "Glass Linings," S. W. McCann.

Mechanism of Electropolishing. T. P. Hoar and J. A. S. Moway. Nature **165,** 64–65 (January 14, 1950).

Studies in the electropolishing of nickel, to be reported in detail elsewhere, have led to formulation of a hypothesis for its mechanism, which may prove to have general application.

Theory of Rate Processes as a Means of Studying Plating Reactions. Donald G. Rogers and Arthur A. Burr. J. Electrochem. Soc. **97,** 92–98 (March, 1950).

Suggestions based on equations adapted from the literature are made for a method of study of plating cells where current efficiency is less than 100 per cent. A procedure is outlined involving current-voltage curves. Data for the plating of chromium from chromic acid show applicability of the equations and indicate the possibility of this method of study for irreversible cells. Effect of sulfate ratio was studied.

"Prepolishing" Before Forming. A. H. Allen. Steel **126,** 76-77, 94 (April 17, 1950).

Describes and illustrates method employed by a leading automotive-parts plant which practically eliminates tedious and expensive hand polishing of steel stampings prior to plating. Steel sheets are prefinished flat, coated with water-soluble plastic, drawn, then cleaned.

Closing Research-Manufacturing Gap Brings about Major Production Economies. R. J. Emmert. Steel **126,** 66–70, 94 (March 27, 1950).

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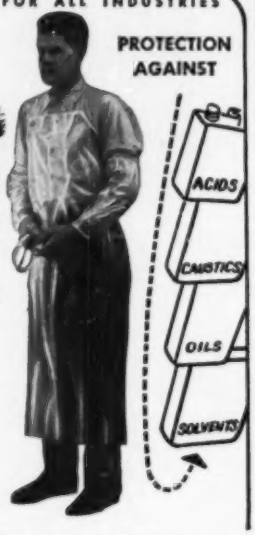

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Treatment of Cyanide Wastes from the Electroplating Industry. Arthur N. Corcoran. Sewage and Industrial Wastes **22**, 228–238 (February, 1950).
Critically surveys various methods for cyanide wastes derived from a variety of metallurgical operations. 20 ref.

Resistance to Corrosion of Hard Chromium Deposits. P. Morisset. Metaux & corrosion **24**, 247–260 (November, 1949).
Results of investigation indicate that comparison of the corrosion resistance of the above in different media has value only if conditions of tests are identical. Results of tests in 160 different media under different conditions are tabulated and discussed. 18 ref.

The Disposal of Plating Shop Effluents. A. E. J. Pettet. J. Electrodepositors' Tech. Soc. **25**, Preprint (1950).
Describes source and nature of waste waters and discusses their effect on streams and on disposal of sewage. Treatments for chromates, cyanides, salts of heavy metals, and acids are presented. 21 ref.

Surface Finishing Stainless Steel. L. F. Spencer. Iron Age **165**, 73–77 (March 9, 1950); 82-85 (March 16, 1950).
Major considerations and recommendations of equipment and methods as related to physical properties are presented. First part covers grinding; second part, polishing and buffing.

Electrical Resistance and Optimum Composition of Electropolishing Baths. Eugene Darmois, Israel Epelboin and Djafar Amine. Compt. rend. **230.**, 386–388 (January 23, 1950).

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Proposes a method for study of optimum bath conditions by determination of electrical resistance of the solutions simultaneously with maximum resistance of the anodic layer.

Heavy Nickel Plating for Salvage; for Corrosion Resistance. P. J. Ritzenthaler. Iron Age **165**, 98–101 (April 6, 1950).
Describes and illustrates various examples of the above. Claims savings of over 50 per cent on small pieces and as much as 90 per cent on larger equipment by heavy-nickel salvage plating. Parts requiring corrosion resistance may be made of cast iron or other low-cost material by applying a heavy nickel coat as thick as 0.080 inch.

Research on the Electrodeposition of Alloys. II. Structure of the Products. Vincenzo Montoro. Met. ital. **41**, 279–286 (November-December, 1949).
The structure of copper-tin alloy deposits containing 51.5, 61.2, 62.0, and 62.3 per cent tin by X-ray diffraction. Characteristics of supersaturated solid solutions present in the electrodeposits are defined. Data are charted and tabulated. Diffraction patterns are illustrated. 23 ref.

Research on a New Cell for Recovery of Silver from the Electrolytic Bath by Regeneration of the Bath. Luigi Fracchia. Met. ital. **41**, 287–291 (November-December, 1949).
Critically reviews existing methods and proposes use of a new type of diaphragm cell. Method of operation, optimum conditions, and economical aspects of this method are discussed. Data are tabulated.

The Corrosion Resistance of Hard-Chromium Deposits. Heinz W. Dettner. Metalloberflaeche **4**, sec. A, 33–37 (March, 1950).
Shows experimentally that above depends on the conditions of electroplating and that the lowest corrosion resistance is obtained when the bath temperatures are between 45 and 53° C. Differences in corrosion resistance are explained on the basis of different structural modifications of the deposit. Includes graphs and photographs. 13 ref.

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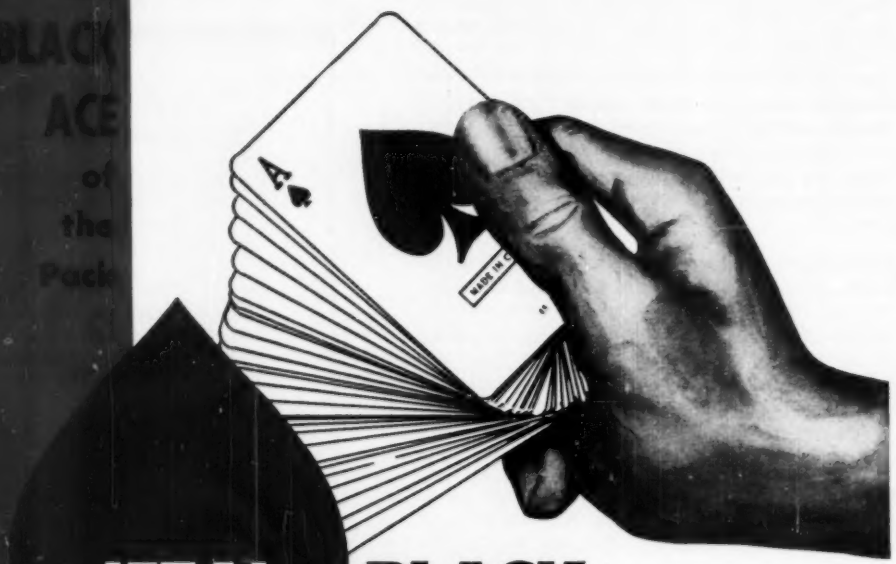

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Copies of patents may be obtainted by writing to Commissioner of patents, Washington 25, D.C. Price 25 cents each.

No. 2,501,737, March 28, 1950—Solution for Plating Metals with Gold—R. W. Porter, Jr. and C. M. Jones.

One of the uses to which our invention may be put is the plating of radio tubes and other electron devices. It may also be used in plating the interior surface of a hypodermic needle . . .

We have found that various metals, for example nickel, tungsten and molybdenum, can be plated with gold . . .

CLAIM 1. A solution for plating metals with gold by immersion only, comprising before the dissolution thereof in distilled water, the following ingredients in substantially the proportions by weight hereafter stated, to wit, gold chloride 0.79 per cent, nickel chloride 0.79 per cent, tribasic sodium phosphate 9.57 per cent, potassium cyanide 9.57 per cent, acetic acid 3.78 per cent, and distilled water 75.50 per cent.

Claim 2. . . . nickel carbonate . . . (for nickel chloride).

CLAIM 3. (omits nickel salts.)

3 claims.

References cited: U. S. Patents 744,170; 1,208,507. F. C. Frary, "Electrodeposition of Gold and Silver", University of Minnesota publication, April 5, 1913, p. 26.

No. 2,522,474, September 12, 1950—Treatment of Zinc Surfaces—George B. Watkins and Richard S. Shull, assignors to Battelle Memorial Institute.

Our invention relates to the treatment of zinc surfaces . . . more particularly, with the production of coatings on zinc or zinc-base alloy surfaces and on galvanized surfaces. More specifically, it relates to the production of decorative and corrosion-inhibiting coatings on zinc, zinc-base alloy, and galvanized surfaces by treating such surfaces with solutions containing selenium or tellurium.

Production of decorative coatings on zinc in acid baths

(a)	Selenium dioxide, grams	10
	Sodium dichromate, grams	10
	Sulfuric acid, cc	10
	Water, cc	400–1000
(b)	Selenium dioxide, grams	10
	Sulfuric acid, cc	10
	Water, cc	400–1000
(c)	Selenium dioxide, grams	10
	Sodium dichromate, grams	5
	Phosphoric acid, cc	10
	Water, cc	400–1000

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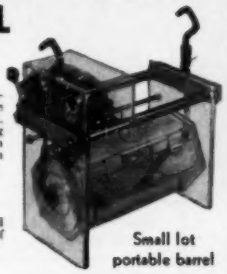

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(d)	Selenium, grams	5–10
	Sodium hydroxide, grams	30
	Water, cc	300–500
(e)	Selenium dioxide, grams	10
	Potassium ferricyanide, grams	20
	Sodium hydroxide, grams	20
	Water, cc	300–500
(f)	Tellurium dioxide, grams	10
	Potassium ferricyanide, grams	20
	Sodium hydroxide, grams	20
	Water, cc	300–500
(g)	Selenium dioxide, grams	10
	Sodium ferrocyanide, grams	20
	Sodium hydroxide, grams	20
	Water, cc	300–500

CLAIM. A method of treating a zinc surface which comprises first treating said surface with an aqueous solution containing sufficient amount of a dissolved ionizable compound of an element selected from the group consisting of selenium and tellurium to produce an adherent, colored coating on said zinc surface and subsequently treating said coating with a mineral acid solution.

References cited: U. S. Patents 1,308,092; 1,359,972; 1,719,930; 1,723,067; 1,867,959; 1,961,030; 2,010,870; 2,018,388; 2,186,085; 2,193,246; 2,266,922; 2,276,353; 2,282,511; 2,322,208; 2,408,116. German Patent 525,-664. Chem. Abs. **29,** 5029 (1935).

No. 2,523,432, September 26, 1950—Cadmium Plating Process and Composition—Richard O. Hull.

EXAMPLE I	*grams per liter*
Sodium cyanide	130
Cadmium oxide	30
Nickel sulfate	0.5
Sulfonated menhaden oil	1.0

CLAIM 1. An aqueous cyanide-cadmium plating bath comprising from about 0.3 to 1.6 grams per liter of sulfonated cod oil.

9 claims, 5 examples.

References cited: U. S. Patent 2,143,760. Brocklesby, "Marine Animal Oils", Bulletin LIX, Fisheries Research Board of Canada, Ottawa (1941), pp. 345, 346. Trans. Electrochem. Soc. **78,** 345, 346 (1940).

No. 2,523,973, September 26, 1950—Plating Rack—R. S. Snyder, assignor to Monroe Auto Equipment Company, Monroe, Mich.

CLAIM 1. A plating rack comprising vertically spaced top-and-bottom substantially horizontal electric-current-carrying bars, a plurality of abutments secured to the bottom bar at points spaced lengthwise of the bottom bar and respectively engageable with the lower end of the parts to be plated, a corresponding number of tubes of electrical insulating material extending through openings formed in the top bar in axial alignment with the abutments for sliding movement in directions toward and away from the abut-

ments said tubes having portions disposed above and below said top bar, an electric current-carrying rod secured in and extending axially of each tube and having lower ends respectively engageable with upper ends of the parts to be plated, electrically conductive coil springs respectively surrounding the ends of the tubes extending above the top bar and having the lower ends seated on the top bar, and means respectively securing the opposite ends of the springs to the upper ends of the rods and to the top bar so as to yieldably urge said rods in a direction toward said abutments, and means for connecting said current-carrying bars to a source of electric current.

2 claims, 5 figures.

References cited: U. S. Patents 1,215,856; 1,838,187; 2,118,957; 2,177,453; 2,316,609; 2,389,904. Metal Ind. **67**, 170, 171 (September 14, 1945).

No. 2,524,010, September 26, 1950—Electrodeposition of Nickel—Arthur H. DuRose and Paul W. Moy, assignors to The Harshaw Chemical Company.

CLAIM 1. A process of producing bright deposits of nickel comprising electrolyzing an aqueous acid solution of a nickel electrolyte of the class consisting of nickel sulfate and mixtures of nickel sulfate with nickel chloride, such solution also containing an effective amount of each of two cooperating addition agents, one of such addition agents being ethylene cyanohydrin and being maintained in said solution in concentration of from 0.1 to 1.0 gm per liter and the other of such addition agents being benzene monosulfonic acid and being maintained in said solution in concentration from 0.2 to 10 gm per liter.

5 claims.

References cited: U. S. Patents 2,085,754; 2,238,861. German Patent 670,220. Linnick, Metal Finishing **39**, 611 (November, 1941). Henricks, Metal Ind. **61**, 379, 380 (December 11, 1942).

No. 2,524,040, October 3, 1950—Electroplating Zinc and Electrolyte Therefor—Allan E. Chester and F. F. Reisinger, assignors to Poor & Company, Chicago, Ill.

CLAIM 16. The process of electrodepositing zinc from a cyanide-zinc plating bath which comprises depositing zinc from an aqueous cyanide-zinc plating bath containing zinc gluconate and a quantity of water-soluble chemically combined reaction product of gelatin with gluconic acid in proportions corresponding to about 34 grams of gelatin and 100 cc of 50 per cent gluconic acid digested together from one-half hour to one hour at a temperature of from 80° F to 120° F to form a gel followed by the addition of an amount of water sufficient to dissolve the gel, said quantity corresponding to about 60 cc to 80 cc of the resultant solution of gelatin-gluconic acid reaction product in water per gallon of aqueous cyanide-zinc plating bath.

16 claims, 3 examples.

References cited: U. S. Patents 694,658; 1,894,669; 2,196,588; 2,390,511; 2,458,504; 2,461,809.

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QQ-P-416	"Lithoform"
	"Zinodine"
RR-C-82	"Lithoform" No. 32
MIL-C-5541 (See also QPL-5541-1)	"Alodine"
MIL-S-5002	"Alodine"
	"Granodine" (Dip, Spray and Brush grades)
JAN-C-490, Grade I	"Granodine" (Dip, Spray and Brush grades)
JAN-F-495	"Granodine" (Dip, Spray and Brush grades)
	"Lithoform"
JAN-L-548	"Permadine"
AN-E-19	"Alodine"
	"Zinodine"
AN-F-20	"Alodine"
	"Granodine" (Dip, Spray and Brush grades)
	"Lithoform"
	"Permadine"
	"Thermoil-Granodine"
	"Zinodine"
	(See also U.S.A. 3-213)
U.S.A. 57-0-2	
Type II, Class A	"Thermoil-Granodine"
Type II, Class B	"Permadine"
Type II, Class C	"Granodine" (Dip, Spray and Brush grades)
U.S.A. 51-70-1	
Finish 22.02, Class A	"Thermoil-Granodine"
Finish 22.02, Class B	"Permadine"
Finish 22.02, Class C	"Granodine" (Dip, Spray and Brush grades)
U.S.A. 50-60-1	"Granodine" (Dip, Spray and Brush grades)
U.S. Navord O.S.675	"Alodine"
U.S.N. Appendix 6	"Lithoform"
Navy Aeronautical M-364	"Permadine"
	"Thermoil-Granodine"
AN-C-170	(See MIL-C-5541)
U.S.A. 72-53	(See AN-F-20)
AXS-1245	(See JAN-C-490)

Rust Removing and Metal Conditioning Chemicals

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JAN-C-490, Grade II	
Type 4	"Deoxidine" Nos. 126, 512, 526, 624, 670
Type 5	"Deoxidine" Nos. 170, 171, 670
U.S.A. 3-213	
Type I	"Deoxidine" (Wash-off grades)
Type II	"Deoxidine" (Wipe-off grades)

Metal Cleaning Chemicals

SPECIFICATION NUMBER	ACP SPECIFICATION CHEMICAL
JAN-C-490, Grade II	
Type 2	"Ridoline"
Type 6	"Ridosol"
U.S.A. 3-192	"Ridoline" No. 3192
U.S.N. Appendix 6	"Deoxidine"

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No. 2,524,619, October 3, 1950—Electrodeposition of Nickel—Henry Brown, assignor to The Udylite Corporation.

(Table 1 contains composition of 8 addition agents; Table 2 contains solution composition for white nickel, bright nickel, cobalt, bright cobalt, bright cobalt-nickel, zinc, iron (chloride), iron (sulfate), copper (sulfate).

CLAIM 1. In a process of electrodepositing nickel, the step which comprises electrolyzing an aqueous acid nickel solution consisting essentially of a material selected from the group consisting of nickel sulfate, nickel chloride, and mixtures thereof, said aqueous solution also having dissolved therein in a concentration of at least 0.05 gram per liter a soluble monosulfate of a water-soluble aliphatic polyhydride alcohol the hydrogen of at least one hydroxy group of which is replaced by an alkyl radical containing from 8 to 18 carbon atoms, the sulfate group being linked directly to an hydroxy group of the alphatic polyhydric alcohol.

CLAIM 2. . . . said aqueous (nickel) solution having dissolved therein a monolauryl ether of a glycol mono-sulfate in concentration of at least 0.05 gram per liter.

4 claims.

References cited: U. S. Patents 2,171,842; 2,389,179; 2,389,180; 1,389,181. Products Finishing **6**, 56–59 (November, 1941). Ind. Eng. Chem. **31**, 66–69 (1939); **33**, 16–22 (1941).

No. 2,524,648, October 3, 1950—Electrodeposition of Nickel—Henry Brown, assignor to The Udylite Corporation.

(Table I contains composition of 7 addition agents; Table 2 contains solution composition for white nickel, bright nickel, cobalt, bright nickel-cobalt, zinc, iron (chloride), iron (sulfate), copper (sulfate).

CLAIM 1. In a process of electrodepositing nickel, the step which comprises electrolyzing an aqueous acid nickel solution of a material selected from the group consisting of nickel sulfate, nickel chloride, and mixtures thereof, said aqueous solution having dissolved therein a minor proportion of at least 0.05 gram per liter of a soluble aliphatic sulpho-mono-carboxylic ester of a water-soluble aliphatic polyhydric alcohol.

CLAIM 2. . . . said aqueous solution also having dissolved therein a minor proportion of at least 0.05 gram per liter of lauryl mono-ether of diethylene glycol sulpho-acetate.

4 claims.

References cited: U. S. Patents 2,389,135; 2,389,179; 2,389,180; 2,389,181.

No. 2,524,912, October 10, 1950—Process of Electrodepositing Copper, Silver or Brass—George W. Jernstedt, assignor to Westinghouse Electric Corporation.

CLAIM 4. In the process of depositing a metal from the group consisting of copper, silver and brass upon

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a base member from an electrolyte suitable for the electrodeposition of the metal, the steps comprising applying the electrolyte to the base member, passing an electrical current through the base member and electrolyte at a potential below 10 volts to render the base member cathodic for from 2 to 40 seconds to electrodeposit metal on the base member, terminating the cathodic current, passing an alternating current through the base member and electrolyte at a potential of from at least 20 to 110 volts for about 0.2 to 4 seconds, at least one complete cycle of alternating current being applied during the time interval, the alternating current being terminated during the anodic portion of the cycle, and repeating the cathodic current and alternating current cycle until a desired thickness of metal has been electrodeposited on the base member.

7 claims, 2 figures.

References cited: U. S. Patents 1,431,047; 1,534,709; 1,565,216; 1,566,265; 1,712,284; 1,785,389; 1,918,605; 1,935,395; 2,063,760; 2,181,773; 2,451,341. "Modern Electroplating" (1942), p. 173. Trans. Faraday Soc. No. 85, part 6, pp. 348, 358 (June, 1928). Trans. Electrochem. Soc. **41**, 151–180 (1922).

No. 2,525,942, October 17, 1950—Electrodepositing Bath and Process—Wayne A. Proell, assignor to Standard Oil Company, Chicago, Ill.

This invention relates to novel electrochemical baths and processes employing same. More particularly it relates to electroplating baths wherein the principal or substantially the sole anion employed for the transport of electrical current is derived from an alkane sulfonic acid.

CLAIM 1. An electroplating bath for the electrodeposition of a metal ion comprising essentially an aqueous solution containing said metal ion capable of being deposited by electrolysis to yield a normally solid electrodeposit, an alkanesulfonate ion having between 1 and 5 carbon atoms in the alkyl group as the principal anion, the concentration of the metal alkanesulfonate in said solution being at least about 10 per cent by weight and not greater than the saturation concentration of said alkanesulfonate in said solution, and between about 0.01 and 5 per cent based on said alkanesulfonate of an alkanesulfonate ion having between 10 and 30 carbon atoms in the alkyl group.

CLAIM 2. The electroplating bath of Claim 1 wherein the aqueous solution comprises essentially lead ions.

CLAIM 3. . . . comprises essentially nickel ions.

CLAIM 4. . . . comprises essentially cadmium ions.

CLIAM 5. . . . comprises essentially silver ions.

CLAIM 6. . . . comprises essentially zinc ions.

14 claims.

References cited: U. S. Patents 905,837; 1,947,652; 1,961,160; 2,117,415; 2,147,507; 2,187,338; 2,195,409; 2,232,128; 2,398,426; 2,401,428. J. Am. Chem. Soc. **61**, 3210–3216 (1939). Ind. Eng. Chem. **33**, 1546–1548 (December, 1941). Metal Ind. **65**, 330–332 (November 24, 1944).

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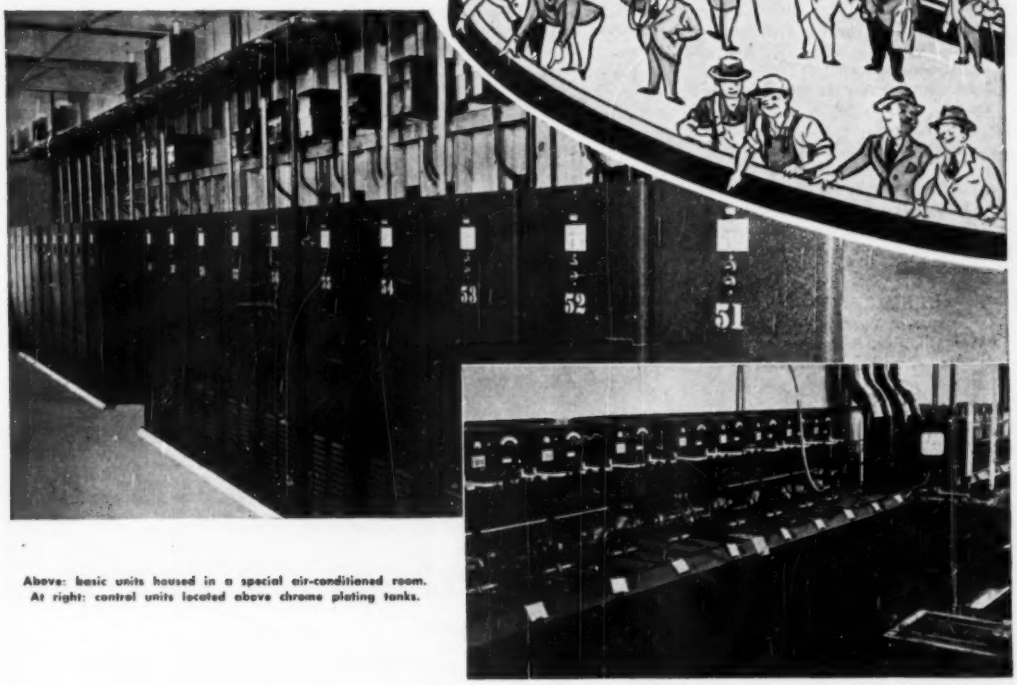

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One of the many advantages of Richardson-Allen Selenium Rectifiers vitally important to the plater is the fact that they draw only the current necessary to plate the work in the tanks. They operate efficiently at ¼, ½ and ¾ load as well as at full load. So, as Perfect Circle Piston Rings are hard chrome plated, to extremely critical specifications, it was decided to employ Richardson-Allen Selenium Rectification for this work because of the perfect and infinitesimal voltage control it affords.

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Branch News

DETROIT BRANCH

ANNUAL EDUCATIONAL PROGRAM
AND DECEMBER PARTY
Saturday, December 2
Statler Hotel

Educational Program at 2:00 P. M.

Chairman, W. J. Neill, A. E. S. President

Speakers: Mr. George Jernstedt, Westinghouse Electric Company, "Applications of Wes-X Copper and P. R. Plating".

Mr. Harland V. Ogle and Dr. E. T. Ewing, Michigan State College, "The Distribution of Metallic Impurities in Nickel Deposits".

General interest address by a prominent executive in the automobile industry.

Banquet at 7:00 P. M.
Main Ballroom, Statler Hotel
Entertainment, Dancing

Tickets for Banquet and Entertainment may be obtained from Carl E. Heussner, 552 Brookside Drive, Birmingham, Mich., at $7.50 per person. The Educational Session is open to all interested parties.

CHICAGO BRANCH

ANNUAL EDUCATIONAL SESSION
AND PARTY
Saturday, January 27, 1951
Stevens Hotel

Symposium on "Preparation of Metals for Electroplating" at 2:30 P. M.

Speakers: Mr. C. F. Nixon, Ternstedt Division, General Motors Corporation, Detroit, "Polishing and Buffing".

Dr. Foster D. Snell, Foster D. Snell, Inc., "Emulsion, Solvent, and Alkaline Cleaning"

Dr. Cloyd C. Snavely, Battelle Memorial Institute, Columbus, Ohio, "Pickling and Bright Dipping"

Banquet at 7:30 P. M.
Dinner—Entertainment

Tickets from Paul Glab, 882 N. Pauline Street, Chicago, Ill.

Room reservations in Stevens Hotel: Mention attendance at A. E. S. party

R. F. LEDFORD, *Correspondent*

NEWARK BRANCH

ANNUAL CHRISTMAS PARTY
AND BANQUET
Saturday, December 16
Hotel Robert Trent

Educational Session at 2:00 P. M.

1. Film presentation
2. Dr. W. A. Wesley, The International Nickel Company, "Porosity and Its Effect in Electroplating"
3. H. E. Shearer, "Production Brass Plating"

Banquet at 7:00 P. M.
Floor Show—Dancing

EUGENE WAGNER, *Publicity*

ALLENTOWN-READING BRANCH

The regular monthly meeting on October 18 was held in Spurgeons Hotel, Allentown, Pa. After the dinner, PRESIDENT HOWARD E. SCHEARER presided over a very brief business session at which MRS. PEARL T. TREISBACH was elected to active membership.

The speaker of the evening was DR. A. S. KOHLER, Chief Chemist of Frederick Gumm Chemical Company, whose subject was "Barrel Deburring". He discussed thoroughly the limitations and advantages of tumbling operations, as well as the equipment, compounds and media used for various types of work and metals to obtain the desired results.

JAMES F. RIEGEL,
Secretary-Treasurer

BOSTON BRANCH

On June 22, with VICE-PRESIDENT JEVELY presiding, MANSON GLOVER reported on the Convention highlights and financial status and that thanks of many visitors still were coming in. The Branch would like to have the Convention again in 1959.

A. E. FLORES was appointed chairman of a possible Moonlight Sail in June, 1951. April 7, 1951 will be the date for the Annual Banquet and Technical Session.

STAN KNIGHT reported for the Nominating Committee, and the following were elected to office:

President—LEONARD A. CHESWORTH
First Vice-President and Membership Chairman—JAMES ANDERSON
Second Vice-President and Research Chairman—KENNETH R. CORSON
Librarian—HAROLD NARCUS
Secretary-Treasurer—GEORGE P. SWIFT,
Board of Managers—MANSON GLOVER, ANDREW W. GARRET, EDMUND S. JEVELY
Sergeant-at-Arms—ELTON A. FLORES

Inasmuch as the scheduled speaker and movie failed to appear, the members enjoyed a general discussion, with coffee and sandwiches.

GEORGE P. SWIFT, *Secretary*

BOSTON BRANCH

On October 5, MANSON GLOVER presented the final report of the Convention Committee, which showed net profits to the Branch and Society of approximately $450.00 each. The report was accepted and the committee discharged with thanks.

A new course in elementary electroplating was announced as being given on Tuesday evenings at M. I. T. under the auspices of the Massachusetts Department of University Extension. It was voted not to participate in the Annual Regional Meeting, the proposed two or three-day session at a resort hotel appearing too expensive even at out-of-season prices.

The new Librarian, HAROLD NARCUS, presented as his first speaker our new President, Mr. LEONARD A. CHESWORTH of United-Carr Fastener Corporation. His subject being "Notes on Barrel Plating", he discussed informally his experiences in round-the-clock cadmium, zinc and nickel plating. Cleaning, coloring, burnishing, continuous purification, and controls were treated in detail.

The question period dealt with solution compositions, preferred voltages, cyanide and carbonate relationships, automatic barrel cleaning, rectifiers for electrolytic purification, temperatures of operation, preferred materials for cylinders, and relationship between current flow and bath temperature.

The meeting was unusually well attended, sixty-five being present.

GEORGE P. SWIFT, *Secretary*

BRIDGEPORT BRANCH

Twenty-six members and guests attended the regular meeting on September 8.

J. G. STERLING reported an attendance of ninety-six at the successful outing on August 19, or ten more than last year. H. C. BROWN reported the passing of TOM BARNES, JR.

The most important business was the discussion of this year's program. R. C. BARRETT proposed one meeting a month, combining the business meeting and the open meeting, for sake of lower cost and larger attendance. The proposal will be voted upon on October 9.

Mr. Barrett then conducted a question-and-answer period and gave a resume of the papers on leveling at the Boston Convention.

J. G. STERLING,
Secretary-Treasurer

BRIDGEPORT BRANCH

DR. B. F. DODGE of the Chemical Engineering Department, Yale University, was the featured speaker at the Open Meeting and Educational Session on September 22. His informal talk on "Disposal of Plating Room Wastes" dealt with methods of disposal of cyanides, chromates, cleaning solutions, etc., and their effects on the pollution of Connecticut waterways. Small industries are now required to reduce pollution and can obtain money for that purpose. Reference was made to the publications in PLATING, which should be read by all dealing with plating or pickling.

J. G. STERLING,
Secretary-Treasurer

CHICAGO BRANCH

At the October 13 meeting 130 members and guests were present to hear MR. FRANK SAVAGE, Past President of the A. E. S., speak on "Auxiliary Equipment in the Plating Room".

This informative talk covered such items as automatic *p*H control, automatic solution-level control, and the use of conductivity cells for returning boiler condensate. While much of this equipment is not new in our industry, it was nevertheless revealing to all to hear about the correct applications. The excellent paper was followed by a lively discussion period.

The Branch had as its guest for the evening members of the Chicago Electroplaters' Institute. A large number of its members was present and contributed much to the success of the meeting.

R. F. LEDFORD, *Correspondent*

CINCINNATI BRANCH

An enthusiastic group opened the 1950-1951 season on September 27 with an excellent dinner meeting. Before the meeting got under way, a film entitled "Cross Roads in the Sky", depicting the necessity for a new airport in Cincinnati, was shown.

PRESIDENT EZRA BLOUNT asked the Secretary to read various pieces of correspondence from the National Office which had been received during the summer. He then announced that the Proposed By-Laws had been returned by the A. E. S. Law Committee with only three minor suggestions. The By-Laws were then adopted by unanimous vote.

MR. H. C. IRVIN of Allied Research Products, Inc., Baltimore, Md., was the guest speaker and devoted his entire time to discussing "Free Enterprise", with particular emphasis on the American way of life *vs* socialism and communism. The meeting concluded with a social hour sponsored by the Northwest Chemical Company, Detroit.

CHARLES WISE, *Secretary*

CINCINNATI BRANCH

Thirty-eight members and guests were present at the meeting on October 25. Following dinner and a short movie on sports, MR. PAUL O. BLACKMORE, Director, Basic Development Laboratories, Interchemical Corporation, Newark, N. J., addressed the Branch on the subject, "Adhesion Problems in Metal Painting".

By means of slides Mr. Blackmore described the two types of adhesion which act to keep a paint film on a metal or wood surface. He stressed that absolute cleanliness of the surface was essential. He then described in detail the Interchemical Adherometer. The question-and-answer period which followed demonstrated the members' interest in the subject, which had attracted two members each from Richmond, Ind., approximately 60 miles from Cincinnati, and Maysville, approximately 50 miles away.

The usual social hour followed. We were pleased to have as guest MR. HARVEY J. JOHNSON of the Belke Manufacturing Company, Chicago.

CHARLES WISE, *Secretary*

DAYTON BRANCH

The speaker on October 6 was MR. HAROLD REINDL, Metallurgist of the Inland Manufacturing Company, Division of General Motors Corporation, Dayton, Ohio. Mr. Reindl gave a very interesting and enlightening lecture entitled "Metal Deposition by Vaporization". The equipment used for this comparatively new process was shown with slides. It consisted of vacuum and diffusion pumps, bell jars, heating element, and power source. For satisfactory deposition a pressure of only 1 micron of mercury must be maintained, and the thin strips of foil or wire must be heated to its vaporization temperature. In the work done at Inland Manufacturing Company, on plastic auto-horn buttons, emblems, etc., a pound of aluminum will cover about 750,000 parts. Aluminum is used in most of their work, but they have successfully deposited such metals as silver, gold, zinc, and cadmium.

The intricate masks used in the production of the numerous parts are formed by electroforming and filed by hand. For some parts, as many as four different masks are used. Many samples were shown, including mirrors of various metals, so-called transparent mirrors, and many novelty items.

The remainder of the evening was devoted to questions and answers and informal discussions. Although not enough time was left for showing the film on steel alloys, the twenty-five members and

friends went home feeling that the evening was well spent.

On October 20, twenty-seven members and friends made a tour of the Champion Paper and Fiber Company plant at Hamilton, Ohio, one of the largest of its kind in the country. All present realized that they saw a very interesting product being manufactured.

R. M. Clinehens, *Secretary*

DETROIT BRANCH

Around 200 members were present at the meeting on October 6.

The technical program centered around the Society's Research Program. Following a few introductory remarks by President Hahn, Mr. Guy M. Cole, of the Ternstedt Division, General Motors Corporation, and Vice-Chairman of the A. E. S. Research Committee, presented a word picture of the progress made so far in the various projects. He stressed their importance to everyone in the plating industry and pointed out that additional funds were imperative to finance further development.

The meeting then resolved itself into an open forum. A number of members of the Research Directing Subcommittee supplied the answers to questions from the floor.

Preceding the discussion of the research program, an interesting picture of the manufacture of glass, "Sand and Flame", was shown.

S.E. Sangster,
Publicity Committee

GRAND RAPIDS BRANCH

Approximately seventy-five members and guests were present at the meeting on October 13.

A motion was carried to the effect that Branch officers be elected in February and installed in March. All agreed that incoming officers would have an easier time relieving old officers if installed in March instead of in May. Mr. McCann, Inspector for U. S. A. A. F. Procurement Office, gave the Branch information on how to become a U. S. A. A. F. Approved Plating Source.

The guest speaker, Dr. A. E. Chester, Director of Research at Poor & Company, presented an interesting and informative discussion of "The Promat Plating Processes in Relation to Defense Contract Specifications".

The meeting was concluded with the usual buffet lunch served by the hotel.

V. V. Ventolo, *Secretary*

HAMILTON BRANCH

The first meeting of the season was held at the West Plant of Canadian Westinghouse. Not only was there a good turnout of members, but a considerable number of visitors were present.

Guest speaker was Mr. J. Saimoto of the United Chromium Limited, Toronto, Ont., who spoke about "The High Speed Self Regulating Chromium Solution". The merits and demerits of this solution were discussed thoroughly to the accompaniment of slides. Many samples of chromium plated parts were passed around. An interesting discussion period followed.

J. C. Harden, *Correspondent*

HAMILTON BRANCH

The Branch passed its most important landmark since it was organized last year when, in October, it was presented with its Permanent Charter by Mr. C. F. Nixon, First Vice-President of the Society. Mr. Nixon was ably assisted throughout the evening by Mr. S. S. Johnston, Past President of the A. E. S.

The business of the evening was preceded by a dinner at Club 222, to which all were invited. Many members from neighboring Branches attended, and new friendships were made and old ones renewed.

Having been introduced by J. W. Beatt, Branch Secretary, Mr. Nixon related how the A. E. S. had originated and developed through the years. He illustrated his talk with slides showing the growth of the A. E. S. since its inception and pictures of the present executive and the headquarters. He then presented the Charter, which was accepted by K. Cranfield and William Young, present and past Presidents of the Branch. Mr. Nixon thanked Mr. Young for all he had done in helping to organize the Branch and expressed faith in Mr. Cranfield to carry on the job.

Mr. Nixon then presented a most interesting lecture on "Zinc Diecastings—Their Preparation and Plating", which was accompanied by slides.

He pointed out that because the structure of the diecasting tended to be more dense near the surface, it was a mistake to polish excessively. Attempts to remove the small pit marks on the surface cause larger ones below the surface to be exposed. The surface of the casting should be of such a quality that buffing is unnecessary. Most plating troubles can be traced to the cleaning instead of the plating itself.

A lively question period followed, during which many problems were solved to the satisfaction of all.

J. Harden, *Correspondent*

HARTFORD BRANCH

The regular monthly meeting on October 16 had an attendance of approximately fifty members and guests. An American Airlines representative gave a short talk on "Flying to the Los Angeles Convention", including a visit to Mexico. He then presented a colored movie entitled "Skyway to Mexico". George Hogaboom delivered his monthly talk on government plating specifications.

The speaker of the evening was Mr. Richard Furbush of the Adams Engineering Company. Discussing "Racks", he briefly outlined their development from the early bare racks to the present ones with rack coatings, replaceable tips, and work holders. In design of racks, thought should be given to the spacing of parts on the rack to eliminate shadowing, gas pockets, slow draining, etc.; to its ability to carry the current; to proper work holders for fast loading and unloading; and to making the rack fit the complete plating cycle. Mr. Furbush showed samples of work holders with job applications and a newly designed work holder. Ralph McCahan served as chairman during the discussion period.

Refreshments were served through the courtesy of the W. D. MacDermid Chemical Company.

Stanley Platoz, *Secretary*

JACKSON-LANSING BRANCH

On October 10, in Hotel Porter, Lansing, the J. J. Siefen Company, Detroit, acted as host for the evening. A country-style chicken dinner was served to the thirty-five members and guests.

Mr. Clarence De Groat gave a brief talk about the development of liquid buffing compounds and their advantages. The meeting was then opened to questions from the floor.

After a Westinghouse Electric Company sound movie entitled "Electricity, What Is It"? had been shown, our host furnished liquid refreshments. The discussion of buffing-compound problems continued informally for several hours.

Fred W. Stuckenberg,
Publicity Chairman

LANCASTER BRANCH

On October 13 the Branch made two plant visitations during the afternoon, to Harrisburg Steel Corporation and to C. E. Snyder and Son job-plating shop in Harrisburg.

The dinner meeting was held at Shelley's Restaurant in Steelton. Mr. Arthur W. Logozzo, President of Nutmeg Chrome Corporation and A. E. S. Past President, was the speaker. With "Chromium Plating" as his subject, he showed slides and movies of methods of racking, building of special anodes, and plating of dies and molds, and then answered a number of questions.

Harry A. Saylor, *Secretary*

LOS ANGELES BRANCH

The dinner meeting September 13 had an attendance of sixty-eight members and seven guests. The delegates to the Boston Convention reported and heaped high praise on the Boston Branch, especially for the Clam Bake, the night at the Symphony, and the ladies' program.

The program for the evening was a panel discussion of copper plating. Mr. Stuart Krentel of Shepard & Kent,

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● Has exceptionally high gloss, allowing free drainage and no solution carry-over.

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Branch News

Inc., discussed the use of cyanide copper for immersion deposits, copper striking, decorative finishes, and industrial applications. He enumerated the basic constituents of the different baths, methods of analysis, operating conditions, and treatments. MR. RICHARD WOOLEY of United Chromium, Inc., dealt with the copper pyrophosphate bath and outlined the make-up of a new bath, operating ranges of the constituents, control, and treatments. MR. MYRON ORBAUGH'S, of Boone Engineering Corporation, talk covered two acid copper solutions, the sulfate type and the fluoborate type, their applications, as well as their advantages and disadvantages. An active question-and-answer period followed.

One new member was received. The recent death of member CHARLES RUSSILL was reported and a tribute paid to his memory.

GEORGE MCDONALD, *Secretary*

LOS ANGELES BRANCH

Fifty-seven members and eleven guests were present for the October 11 dinner meeting. One new member was received.

The Chairman for the 1951 Los Angeles Convention, DON BEDWELL, reported progress toward giving all convention visitors the best of accommodations, education and entertainment. The Committee to select a candidate for the Third Vice-Presidency of the National Society reported the selection of MARCUS RYNKOFS and DICK WOOLEY as nominees. The members requested the committee to add one or two more nominees to the list, for a choice at the November meeting.

The speaker was MR. CHARLES BROWN of Bone Engineering Company, who spoke about "Electricity in the Plating Shop". His talk included basic formulae for electrical circuits, conductivity and power loss in bus bars, types of power sources and distribution systems, electric heating of solutions, maintenance of electrical equipment, grounding of equipment, bipolar effects, insulating materials, and other factors encountered in the plating room. A large number of questions followed, and the resulting discussion evidenced the genuine interest of the members.

GEORGE MCDONALD, *Secretary*

LOUISVILLE BRANCH

Because of difficulties in getting into our room at the University of Louisville, the first meeting of the 1950–1951 season got off to a slightly late start. FIRST VICE-PRESIDENT ARTHUR OERTEL, in the absence of PRESIDENT ALBERT STEIDLE who was ill, therefore dispensed with all business and introduced MR. EZRA A. BLOUNT, Editor of Products Finishing. Mr. Blount, with his long experience in the field and ten years of teaching electro-

plating at the Ohio Mechanics Institute, was certainly well qualified to instruct the Branch in the "Fundamentals of Electroplating".

Mr. Blount began by telling of the work of early chemists and physicists in the field of electrochemistry, particularly that of Michael Faraday. He then discussed eight factors affecting the character of electrodeposits. Group discussion was held on each point as it was taken up. The final discussion period was cut short to allow for the showing of a 30-minute, 16-mm educational sound film, "This Is Aluminum".

The Branch is greatly indebted to Mr. Blount for his visit and to the U. S. Bureau of Mines for providing the film.

STANLEY J. BEYER,
Temporary Secretary

LOUISVILLE BRANCH

MR. W. B. HELBIG of The Darco Department, Atlas Powder Company, New York City, was the guest speaker on October 19. During his interesting and informative talk on the "Use of Activated Carbon in the Purification of Plating Solutions", he first discussed the early history of the manufacture of activated carbon and outlined its uses in other industries. Carbon for the electroplating industry receives a special desulfiding treatment. For periodic treatment of plating solutions, the solution should be transferred to an auxiliary tank, the carbon added and mixed thoroughly, and the solution filtered back into the plating tank. For continuous treatment, the filter should be coated with filter aid and then with carbon. The solution should be picked up from one corner of the tank near the bottom, piped through the filter, and discharged in the diagonally opposed corner near the top, *below* the surface of the solution to prevent the intake of excess air.

Activated carbon should not be used in chromium baths because of formation of trivalent chromium. Carbon has an independent equilibrium with each chemical with which it comes in contact, and brighteners and wetting agents should therefore be added in excess of the amount that the carbon will absorb. This rule has exceptions, however, and dealers in these agents should be consulted. Filter area, solids capacity, and rate of filtration were discussed in some detail.

G. H. HILLEBRAND,
Secretary-Treasurer

MELBOURNE BRANCH

Ninety-one members and visitors were present at the fifty-sixth regular meeting on September 21.

ACTING PRESIDENT BOB TAYLOR introduced SECRETARY JOHN DALE, who spoke on "Some Aspects of American Electroplating Practice". A description of the A. E. S. Convention, business sessions, technical papers, and of people he had met was followed by details of the latest American practices and ideas, showing of samples, and quoting of formulae.

Among the points of interest were the use of flat polishing and of liquid tripoli; the use of such very sacrificial cycles as 20:10 or even 20:15 in periodic-reverse-current plating; the importance of very thorough cleaning; increasing attention paid to agitation and solution circulation; use of diaphram tanks and automatic machines. A lengthy question time followed.

ROWLAND H. KELLER,
Assistant Secretary

MILWAUKEE BRANCH

At the 412th regular meeting of the Milwaukee Branch, attended by fifty-seven members and guests, PRESIDENT LESLIE DIVELEY inducted nine new members into the Society and complimented EVERETT ROBINSON and his Membership Committee for their diligence.

The presence of three generations of platers in one family was applauded when MR. JOHN MISZEWSKI, SR., his son, and grandson were introduced to the members.

GENE BOSL introduced the guest speaker, MR. G. W. JERNSTEDT of the Westinghouse Electric Corporation, who gave an engrossing talk on "Copper Plating". He compared the relative merits of cyanide and acid copper and indicated that although new developments in acid copper are making this solution more useful, cyanide copper with metallic brighteners and PR plating will prove to have more advantages.

E. E. PIELLUSCH,
Secretary-Treasurer

MONTREAL BRANCH

The annual banquet in Queens Hotel on October 3 brought out 154 members and guests. The speakers were MR. F. A. TODDS, Manufacturing and Engineering Superintendent of Telephone Communi-

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cations, Northern Electric Company, Ltd., Montreal, and Mr. F. Griggs of Canadian Hanson & Van Winkle Company, Toronto. Also introduced were Mr. K. Wells of the Toronto Branch, who spoke briefly about the importance and headway of the Canadian Research program, Dr. H. L. Kellner of Lea Manufacturing Company, Mr. K. P. Bellinger of Chemical Corporation, Mr. A. Severs of Armilite Corporation, and Mr. J. T. Reisenberg of Lea Products Company.

The entertainment consisted of music throughout the dinner, songs by members, distribution of door prizes, and a floor show. It was one of the best banquets held by the Branch and certainly had the best attendance.

As usual there was much fun in the supply house suites throughout the hotel. The members left well satisfied in the wee small hours.

It was very gratifying to see J. H. Feeley among us and to know that his health permitted him to enjoy himself in the company of old friends.

William Glover, *Secretary*

NEWARK BRANCH

The Branch held its first fall meeting on September 15. A hundred members and guests turned out to make it a huge success. All officers were in attendance, except George Wagner, who is touring Europe.

This meeting started with the showing of two short movie films: one on the subject of "Electrons" and "Electrochemistry".

During the short business session two applications for membership were received, and a generous offer by Mrs. Preston, daughter of the late Charles Proctor, to sponsor a paper award for the members of the Branch was referred to the Board of Managers.

After President Myron B. Diggin had given an eight-minute talk about the progress made by the Society since its inception on June 1, 1913, Mr. Ed. Bowerman of Sylvania Electric Products, Inc., discussed conservation of water supplies from which the plater draws his water for rinsing purposes. To really conserve water, many plants use a series of rinse tanks in which the fresh water flows from one tank to another, atomizing sprays, faucet aerators, timing valves, and different kinds of metering devices.

Louis Donroe acted as moderator of a very stimulating and interesting question-and-answer session.

Light refreshments of beer and sandwiches were then served.

Samuel S. Frey,
Recording Secretary

NEW YORK BRANCH

During the months of July, August and September, the Branch met once a month.

The September and July meetings were brief business meetings.

On August 21, Mr. Adolph Bregman addressed the members on the effect of the Korean situation on the plating industry. Among those present at this meeting were ten members of the U. K. Finishing Team.

Grace Aronson, *Recording Secretary*

PHILADELPHIA BRANCH

The opening meeting of the Fall season was held at the Hotel Benjamin Franklin on September 22. It began with dinner in the Main Dining Room, during which the Hotel's "Ice Show" was enjoyed by the more than fifty members.

Dr. Abner Brenner, National Bureau of Standards, then delivered the 3rd Annual George Gehling Memorial lecture on "The Physical Properties of Electrodeposited Coatings" in the Betsy Ross Room. The physical properties vary with methods and conditions of deposition, e. g., manganese which is normally quite brittle is ductile when deposited from a purified bath but becomes brittle again on standing; Watts nickel is ductile, but bright nickel is hard and brittle; chromium deposited at 50° C is very hard but at 85° is soft enough to machine. Dr. Brenner then dealt with studies of bright and dull nickel in respect to microstructure, hardness, tensile strength, X-ray diffraction patterns, and with the effects of heat treatment, change in *p*H, type of bath, and additions of such salts as sulfates and fluoborates to a Watts bath and ammonium sulfate to a chloride or chloride-acetate bath, on the aforementioned physical properties. In general, anything that produces more sharply defined crystalline structures also makes the deposit more ductile and softer. Referring to chromium deposits, Dr. Brenner described the effects of heat treatment at various temperatures on the physical properties. An interesting observation was that chromium has no ductility at room temperature, any ductility produced at 600° C disappearing on cooling.

Dr. Brenner exhibited a wide variety of specimens and illustrated many of his data with slides. In addition, he showed specimens illustrating the Ollard, Jacquet, and Bureau of Standards nodule adhesion tests and described them briefly. The Bureau's film on the nodule adhesion test was shown. Several questions were asked at the conclusion of the address.

After Librarian Hirsch had given a eulogy in the memory of George Gehling, President Heiman complimented T. M. Rodgers on the excellent arrangements for the dinner and show. Four new members were admitted.

I. Wm. Marcovitch, *Secretary*

PITTSBURGH BRANCH

Membership and attendance have become two important words among Pittsburgh Branch members during the past months. Vice-President Bob Woofter, who serves as Chairman of the Membership Committee, has announced that contest plans are well under way, with worthy prizes for good attendance records and bringing in new members. Six new members have already been added this year.

The speech by Mr. R. R. West, Division Manager of the Brown Instrument Company, Philadelphia, on the subject of "Instrument Aids to Electroplaters", was well received and spiritedly discussed at the October meeting. The job platers had their turn at bat and scored frequently.

All members and friends are reminded of the December party, similar to last year's "Milwaukee Night", an affair to be long remembered.

The committee for the campaign of Frank Keller, our candidate for A. E. S. Vice-Presidency, reported progress and continued success in their mission.

J. M. Davidson, *Secretary*

From left to right, second row: Philadelphia Branch Treasurer George M. Long, Manager Robert L. Farren, Secretary I. Wm. Marcovitch, Dr. Abner Brenner, President Dr. Samuel Heiman, First Vice-President George A. Gibbs, Second Vice-President Alfred H. Pope. Behind Dr. Brenner is former President Tom Rodgers, and behind him A. E. S. Past President Frederick Fulforth. Librarian Albert Hirsh is at extreme right

PROVIDENCE-ATTLEBORO BRANCH

DR. E. A. PARKER, who represents the Branch on an Advisory Committee to the State Industrial Code Commission, gave a short report at the October meeting on what the Commission is trying to do in setting up a Safety and Health Code for the electroplating industry in the State of Rhode Island. There have been two meetings of the Committee, devoted to discussion of an American Standards Code and how it would fit in with with the State Code.

MR. MANSON GLOVER of the Glover Coating Company, Malden, Mass., was the speaker of the evening. His discussion of "Tank Linings" was very interesting, and his handling of the English language gave it added zest. He gave a short resume of the development of tank linings from the early '30s to the present time and presented the advantages gained and the causes of failure of various linings.

The usual bull sessions followed.

FRANK W. BOOTHROYD,
Secretary

ROCHESTER BRANCH

The October 16 meeting saw the election of three new members, including one student member. Other business included discussion of the forthcoming Christmas Party and a motion directing the Board of Managers to consider and report on the suspension of dues-delinquent members.

Thirty-six members were on hand to hear MR. C. F. NIXON, A. E. S. First Vice-President, give a slide-illustrated talk about the finishing of zinc-base diecastings at the Ternstedt Division of General Motors Corporation. Following his main talk, Mr. Nixon answered questions pertaining to the Society. This in turn was followed by a social period during which refreshments were served.

WALTER F. SWANTON,
Secretary

SAGINAW VALLEY BRANCH

MR. WILLIAM JACKSON, of the Udylite Corporation, Detroit, talked to forty-five members and guests at the Zehnder Hotel, Frankenmuth, Mich., on October 11. His blackboard discussion covered equipment planning, application, and plating procedures of "Barrel Plating".

Ten officers and their wives attended a Board meeting-dinner at the Flint Tavern, Flint, Mich., on October 25. The men later discussed ways and means of increasing attendance at regular meetings and formulated plans for a Ladies' Night on February 10.

WILMAR W. KAUFMANN,
Recording Secretary

ST. LOUIS BRANCH

The October meeting had an attendance of thirty-five members. It was suggested by VICE-PRESIDENT JULIUS that we give a dance this year and that the President appoint a committee to handle the affair.

After each member had introduced himself, LIBRARIAN ROBINS presented MR. K. P. BELLINGER of The Chemical Corporation, Springfield, Mass., who gave a very interesting talk about "Bright Passivation Treatment of Zinc". PRESIDENT ROBERTS then answered questions that were submitted.

One application for membership was received.

EDWARD HUNLETH, *Secretary*

SOUTHEASTERN BRANCH

Our first meeting in the dining room of the Georgia School of Technology on October 13 was very successful, with an attendance of twenty-one members and guests and a very good steak supper.

It was decided to hold the November meeting in Spartanburg, S. C., PRESIDENT E. J. SLEMONS' home town. Those that attended last year's meeting there still talk about it. Our library committee is progressing with its work; we expect to have three cities taken care of in the very near future.

The guest speaker was DR. R. J. RAUDEBAUGH, Professor of Metallurgy at Georgia Tech., who gave a very interesting talk about metals and their availability.

WM. T. WEYMOUTH, *Secretary-Treasurer*

SYRACUSE BRANCH

The speaker at the meeting on October 16 was MR. TED VOYDA, Chief Chemist, Apothecaries Hall Company, Waterbury, Conn. His topic was "Anodes and Anode Corrosion", and he dealt with available types of anodes and how methods of manufacturing influence their corrosion characteristics. A question-and-answer period followed.

One application for membership was approved. Attendance was twenty-five.

L. S. WOOD,
Secretary

TORONTO BRANCH

The Branch met on September 8, after a two-month adjournment for the summer.

The guest speaker, MR. AL BENNING of The Harshaw Chemical Company, who spoke about "Nickel Plating", dealt particularly with impurities in nickel solutions, how they get there, their effects, and how each one could best be removed.

CY SHOAT, Chairman of the Research Finance Committee and Delegate to the Boston Convention, reported Convention happenings. Members were most interested to hear about the meeting of the Research Committee and its discussion of the Canadian project. It is hoped that this project will get under way in the not too distant future.

A. L. COXHEAD, *Correspondent*

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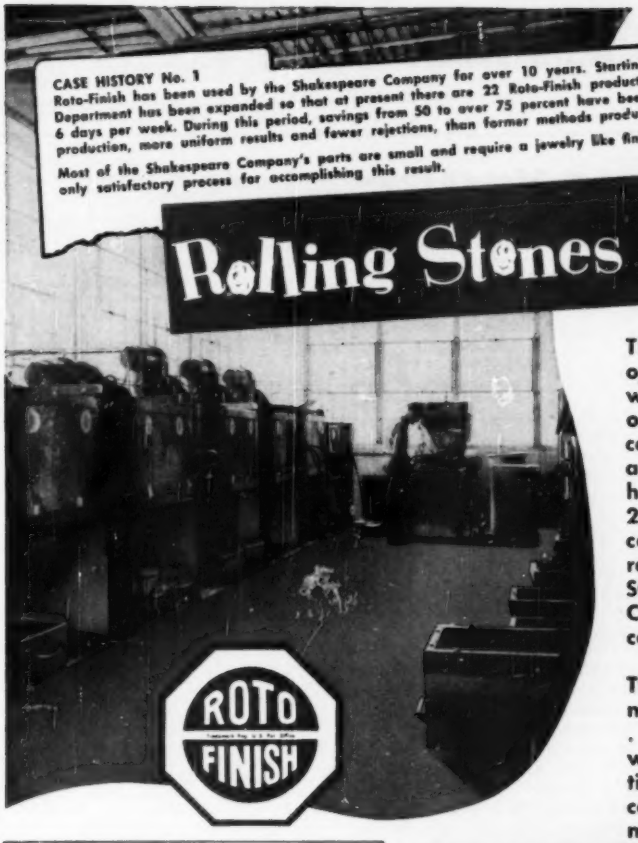
Zinc plated steel, chromium plate on (Q) 755
Zinc plating solutions, determination of traces of chromium in 1057
Zinc plating, hydrogen embrittlement in 366



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The original Roto-Finish Processes operating in industries all over the world are consistently breaking records for low cost finishing. The above case history is just one of many examples where Roto-Finish Processes have reduced finishing costs from 25% to 80%. This original mechanical finishing system of controlled rotary action GRINDS, DEBURRS, DESCALES, POLISHES, BRITEHONES AND COLORS metals and plastics at less cost than other methods.

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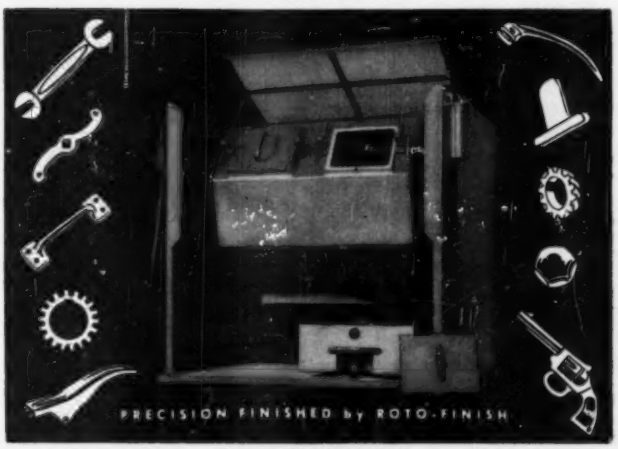
ECONOMICAL DEBURRING

Roto-Finish Deburring—Grinding—Descaling Processes will reduce manufacturing costs and give you uniformly deburred parts. These engineered Processes remove burrs, corners, sharp edges, parting line flash and heat treating scale, at lowered cost. These processes are used for stress relieving and improving the fatigue life of spring type parts.



(Above—Model DW 45-2)

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ROTO FINISH

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SAGINAW VALLEY BRANCH: Walter C. Clark

SYDNEY BRANCH: Frank Moremon

SYRACUSE BRANCH: Charles Cordier, Joseph C. Donadio

MEMBERSHIP-AT-LARGE: Walter Nater, Roy H. Thomas

Reinstatements

BOSTON BRANCH: A. T. Clarke, W. P. Cornyn

HARTFORD BRANCH: Stanley Douda, Leo J. Slominski

Membership Competition

	Membership April 1, 1950*	New Members	Net Change in Membership	Per Cent Net Change
FIRST GROUP				
GRAND RAPIDS	141	6	+17½	+12.4
DETROIT†	483	39	+35	+ 7.2
NEW YORK	280	14	+15	+ 5.4
CHICAGO	372	25	+13	+ 3.5
TORONTO	124	6	+ 3	+ 2.4
HARTFORD	132	5	+ 3	+ 2.3
BOSTON	142	13	+ 3	+ 2.1
MILWAUKEE	124	13	+ 2	+ 1.6
PITTSBURGH	142	2	+ 1½	+ 1.1
WATERBURY	125	5	+ 1	+ 0.8
PHILADELPHIA	192	8	+ 1½	+ 0.8
BRIDGEPORT	155	4	− 1	− 0.6
LOS ANGELES	201	18	− 3½	− 1.7
CLEVELAND	195	22	− 6½	− 3.3
NEWARK	238	4	−10½	− 4.4
SECOND GROUP				
MELBOURNE†	111	15	+ 8	+ 7.2
CINCINNATI	87	4	+ 5	+ 5.7
INDIANAPOLIS	97	9	+ 3	+ 3.1
MONTREAL	68	6	+ 2	+ 2.9
ST. LOUIS	97	9	+ 2½	+ 2.6
BUFFALO	77	1	+ 1	+ 1.3
NEW HAVEN	106	8	− 1½	− 1.4
BALTIMORE-WASH.	85	7	− 4½	− 5.3
DAYTON	97	..	− 5½	− 5.9
ADELAIDE	72	4	− 6	− 8.3
PROV.-ATTLEBORO	112	3	−11	− 9.8
SYRACUSE	85	7	− 9	−10.6
TWIN CITY	71	..	− 8	−11.3
SYDNEY	109	5	−15	−13.8
ROCHESTER	104	7	−17	−16.4
THIRD GROUP				
ROCKFORD	64	9	+ 9	+14.1
ALLENTOWN-READING	37	6	+ 5	+13.5
COLUMBUS	47	3	+ 4½	+ 9.6
ST. JOSEPH VALLEY	66	8	+ 4	+ 6.1
HAMILTON	23	1	+ 1	+ 4.3
SPRINGFIELD	51	1	+ 1	+ 2.0
WESTERN ONTARIO	23	..	.....	.....
LANCASTER	62	1	− 5	− 8.1
SOUTHEASTERN†	54	3	− 5	− 9.2
JACKSON-LANSING	57	..	− 7½	−13.1
SAN FRANCISCO	66	10	− 9	−13.6
LOUISVILLE	25	..	− 4½	−18.0
TOLEDO	49	2	− 9	−18.4
SAGINAW VALLEY	64	1	−12	−18.8
OUTSIDE COMPETITION				
AT LARGE	104	20	+10	.....
IN TRANSFER	27	..	− 2	.....
TOTAL A. E. S.	5,236	337	− 7	− 0.1

Active Membership, November 1, 1950 5,229

*Subject to correction. †Winners of membership competion in 1949–1950.

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TWIN CITY BRANCH: Philip J. King

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MILWAUKEE BRANCH: Michael Brisch, Raymond R. Goodsell
NEW HAVEN BRANCH: John P. Arserio, Konrad Corda, Donald F. Kickiner, Leo R. L'Heureux, Kenneth G. Miles, Henry B. Smith, Fritz Uhlenhaut
TWIN CITY BRANCH: T. P. Daufelt William A. Huntley, Morris J. Kantar
MEMBERSHIP-AT-LARGE: Joaquin M. Agullo, Marcos Brasiavsky, P. R. Deshpande, Ludwik Galuszka, J. v. d. Graef, Vernon F. Henley, Anant T. Pathak, R. Piontelli, W. H. Sawyer

Deaths

DETROIT BRANCH: Gene Lyons
MELBOURNE BRANCH: F. A. Prowse
MILWAUKEE BRANCH: N. F. Gerke
NEW HAVEN BRANCH: John C. Oberender, Robert T. Sammet

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ADELAIDE, AUSTRALIA meets second Wednesday of each month. Address G.P.O. Box 598E, Adelaide, S. A., Australia.

ALLENTOWN-READING meets third Wednesday of each month in Spurgeon's Hotel, Allentown, Pa. Secretary-Treasurer, James F. Riegel, 425 S. 18th Street, Allentown, Pa. Research Finance Committee Chairman, William R. Pfeiffer Jr., 975 Green St., Allentown, Pa.

BALTIMORE-WASHINGTON meets second Tuesday of October, December, February, and April in Baltimore at the Engineers' Club, and of November, January, March, and May in Washington, D. C., at the Garden House, Dodge Hotel. Secretary, George E. Best, c/o Research Department, Mutual Chemical Company of America, 1340 Block Street, Baltimore 31, Md.

BOSTON meets first Thursday of each month in Hotel Statler. Secretary, Dr. George P. Swift, 53 Galen Street, Watertown, 72, Mass. Research Finance Committee Chairman, Eugene P. Carter, c/o United Carr Fastener Corporation, 81 Ames Street, Cambridge, Mass.

BRIDGEPORT meets first and third Friday of each month in Barnum Hotel. Secretary-Treasurer, Joseph G. Sterling, 134 Colony Street, Bridgeport 8, Conn. Research Finance Committee Chairman, Carl Schaefer, c/o Casco Products Corporation, 512 Hancock Avenue, Bridgeport 5, Conn.

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CHICAGO meets second Friday of each month at 8 P. M. at Western Society of Engineers, 84 E. Randolph Street. Secretary-Treasurer, Paul Glab, 882 N. Paulina Street, Chicago, Ill. Research Finance Committee Chairman, Clyde Kelly, 740 W. Englewood, Chicago 21, Ill.

CINCINNATI meets fourth Wednesday of each month at 8 P. M. in Engineering Society Headquarters, McMillan Street and Woodburn Avenue. Secretary-Treasurer, Charles Wise, c/o The Buckeye Products Company, 7020 Vine Street, Cincinnati 16, Ohio.

CLEVELAND meets first Friday of each month in Cleveland Hotel at 8 P. M. Secretary-Treasurer, Harry Pochapsky, 24961 Euclid Avenue, Euclid 17, Ohio. Research Finance Committee Chairman, Howard A. Blouch, 12901 Elmwood Ave., Cleveland 11, Ohio.

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DAYTON meets first Friday of each month in Engineers Club. Secretary, Richard M. Clinehens, 33 W. Market Street, Germantown, Ohio. Research Finance Committee Chairman, Robert L. Ruleff, 1002 Broadview Blvd., Dayton 9, Ohio.

DETROIT meets first Friday of each month in Hotel Statler. Secretary-Treasurer, Joseph Gurski, 8885 Littlefield, Detroit 28, Mich. Research Finance Committee Chairman, W. B. Knight, c/o Knight Plating Company, 3143 Bellevue Avenue, Detroit 11, Mich.

GRAND RAPIDS meets second Friday of each month at 7:30 P. M. in Rowe Hotel. Secretary, Victor V. Ventoli, 225 Fountain Street, N. E., Grand Rapids, Mich. Research Finance Committee Chairman, John W. Putte, 308 Gladstone Avenue, S. E., Grand Rapids, Mich.

HAMILTON BRANCH. Secretary, W. Finlay, 7 Hill St., Hamilton, Ontario, Canada.

HARTFORD meets third Monday of each month in Hotel Bond. Secretary, Stanley Platoz, 26 Erwin Place, New Britain, Conn. Research Finance Committee Chairman, Frank W. Smith, 46 Cottage Street, Meriden, Conn.

INDIANAPOLIS meets first Wednesday of each month at Fox Steak House, 1207 Washington Street. Secretary, Howard Phillips, 1024 Shelby Street, Indianapolis 3, Ind.

JACKSON-LANSING meets second Tuesday of each month alternating between Hayes Hotel in Jackson and Porter Hotel in Lansing. Secretary-Treasurer, E. F. Strefling, 1423 Kelsey Avenue, Lansing 10, Mich.

LANCASTER meets second Friday of each month at 8 P. M. in Thaddeus Stevens Industrial School. Secretary-Treasurer, Harry A. Saylor, 40 N. Poplar Street, Elizabethtown, Pa. Research Finance Committee Chairman, Harry Hovis, Lincoln Highway, West Lancaster, Pa.

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LOUISVILLE meets third Thursday of each month in Room 119, Speed Scientific Building, University of Louisville. Temporary Secretary, Stanley J. Beyer, 1304 Barret, Louisville 4, Ky. Research Finance Committee Chairman, Garland Logsdon, 1519 Central Avenue, Louisville, Ky.

MELBOURNE, AUSTRALIA, meets third Thursday of each month at 8 P. M. in Metallurgy Theatre, Melbourne Technical College, 124 Latrobe Street. Hon. Secretary-Treasurer John J. Dale, c/o Defence Research Laboratories, Maribyrnong, Victoria, Australia.

MILWAUKEE meets first Friday of each month in Red Arrow Club, 774 N. Broadway. Secretary-Treasurer, E. E. Piellusch, 2921 S. 90th Street, West Allis 14, Wis. Research Finance Committee Chairman, James Paulson, 1434 First Wisconsin Bank Bldg., Milwaukee, Wis.

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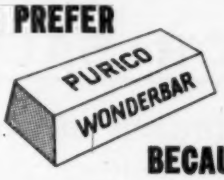

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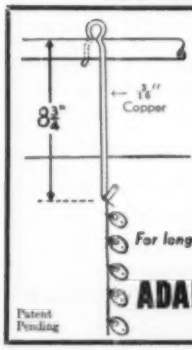

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SAN FRANCISCO meets second Thursday of each month, alternating between El Jardin Restaurant, 22 California Street, San Francisco, and El Curtola Restaurant, 510 17th Street, Oakland. Secretary-Treasurer, Roy Fellom, Jr., 709 Mission Street, San Francisco, Calif.

SOUTHEASTERN meets second Friday of each month in Robert Fulton Hotel, Atlanta, Ga. Secretary, William Weymouth, 173 Clay Street, S. E., Atlanta, Ga. Research Finance Committee Chairman, Dr. Fred W. Cox, Engineering Experiment Station, Georgia School of Technology, Atlanta, Ga.

SPRINGFIELD meets fourth Monday of each month in Hotel Charles. Secretary, P. W. Prouty, 69 S. Park Avenue, Longmeadow 6, Mass. Research Finance Committee Chairman, James Laing, c/o Van Valkenburg Company, Montgomery Street, Williamansett, Mass.

SYDNEY, AUSTRALIA. Secretary-Treasurer, H. Coates, Box 1339, G. P. O., Sydney, N. S. W., Australia.

SYRACUSE meets third Monday of each month in Hotel Syracuse. Secretary, Lindley Wood, 1329 Bellevue Avenue, Syracuse 4, N. Y. Research Finance Committee Chairman, George W. Cavanaugh, 129 Kenwood Avenue, Syracuse, N. Y.

TOLEDO meets first Thursday of each month at Commodore Perry Hotel. Secretary, Gaston Bergeman, 703 Pine Street, Fremont, Ohio. Research Finance Committee Chairman, William Russell, 7th Street at Dixie Highway, Perrysburg, Ohio.

TORONTO meets second Friday of each month in Royal York Hotel. Secretary, R. Stevens, c/o Bryden Brass Company, 927 Dufferin Street, Toronto, Canada. Research Finance Committee Chairman, C. D. Short, 1281 Pape Avenue, Toronto, Canada.

TWIN CITY meets first Monday of each month, October through June, in Hotel Curtis, Minneapolis. Secretary-Treasurer, Robert L. Buckley, c/o Industrial Chemical & Equipment Co., 205 11th Ave. South, Minneapolis 15, Minn. Research Finance Committee Chairman, E. H. Lindemann, c/o Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.

WATERBURY meets second Friday of each month in Elton Hotel. Secretary-Treasurer, Spencer L. Henn, P. O. Box, Dr. B, Cheshire, Conn. Research Finance Committee Chairman, Anthony Maz, c/o Risdon Manufacturing Company, Waterbury, Conn.

WESTERN ONTARIO meets third Friday of each month in William Pitt Hotel, Chatham, Ontario. Secretary-Treasurer, K. W. Farguhar, c/o Wallaceburg Brass, Ltd., Wallaceburg, Ontario, Canada.

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plating

December 1, 1950

Dear Reader:

Again we have the pleasure of wishing you a Merry Christmas with all that this wish includes.

Your first reaction may be that this is a bad time for making merry. "The world situation is serious", you say, "look at all our troubles today and the uncertainties that lie ahead of us. Look at the recent election campaign with its vituperation; everyone can see that we are nervous and jumpy and not at all in the mood for the joys of Christmas". Listening we agree that this is a time for sober thought and stock taking.

But that is not the same as worry about the future. Physicians suspect that fear and allied emotions cause at least half our bodily ills, and the National Safety Council said a few years ago that 80 per cent of all accidents have an emotional basis. What we need is an antidote for worry.

Christmas has fulfilled that function since the beginning of history. On the darkest day of the year man has rejoiced that brighter days are ahead. And looking at history with all its ups and downs we must agree that the average man has more to live for today than ever before.

And so we learn to put fear behind us and make merry.

Merry Christmas!

Sincerely,

Gustaf Soderberg

Future Meetings

NEWARK BRANCH, A. E. S. Annual Christmas Party and Banquet in Hotel Robert Treat, Newark, N. J., on December 16. Educational Session at 2:00 P. M., Party at 7:00 P. M.

DETROIT BRANCH, A. E. S. ANNUAL EDUCATIONAL SESSION AND PARTY in Statler Hotel, Detroit, Mich., on December 2, 2 P. M. and 7 P. M.

SECOND PLANT MAINTENANCE SHOW AND CONFERENCE in the Auditorium, Cleveland, Ohio, on January 15–18, 1951.

AMERICAN SOCIETY FOR TESTING MATERIALS Spring Meeting and Committee Week in Cincinnati, Ohio, on March 5–9, 1951.

BOSTON BRANCH, A. E. S. Annual Technical Session and Banquet in Hotel Statler, Boston, Mass., on April 7, 1951.

FOURTH NATIONAL MATERIALS HANDLING EXPOSITION AND CONFERENCE in International Amphitheatre, Chicago, Ill., on April 30–May 4.

AMERICAN SOCIETY FOR TESTING MATERIALS Annual Meeting in Atlantic City, N. J., on June 18–22.

AMERICAN ELECTROPLATERS' SOCIETY Annual Convention in Hotel Biltmore, Los Angeles, Calif., on June 25–28, 1951.

"Hope to see you at

ALLENTOWN-READING BRANCH

A. E. S. Dinner-meeting, December 20th.

•

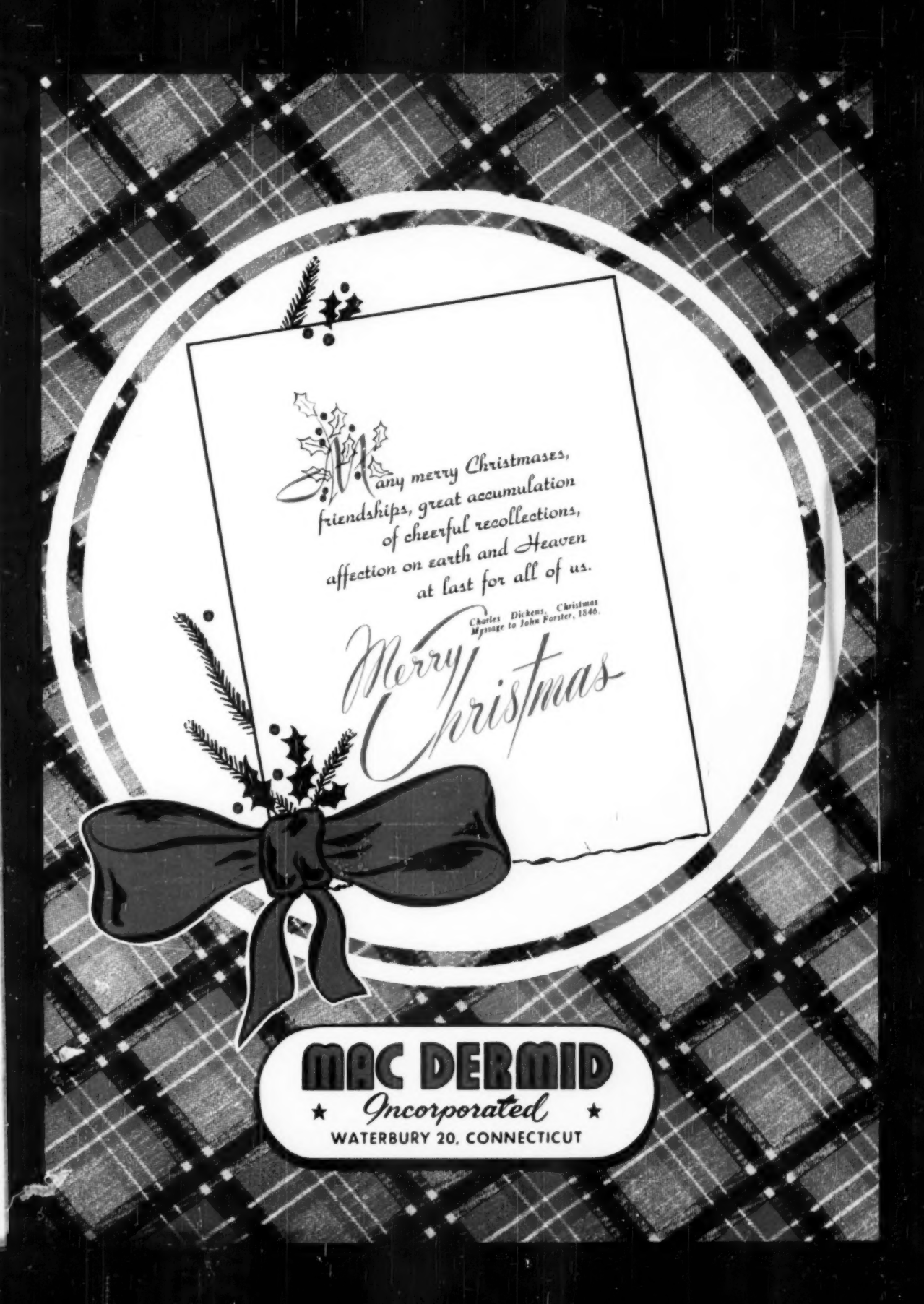
I'll be there to speak to you on:

COPPER STRIPPING NON-DANGEROUSLY

If you can't be there, write for your free copy of the speech."

Wilfred Sullivan

Sulphur Products Co. Inc.
Greensburg, Pa. 8


Many merry Christmases,
friendships, great accumulation
of cheerful recollections,
affection on earth and Heaven
at last for all of us.
Charles Dickens, Christmas
Message to John Forster, 1846.
Merry Christmas
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